AD-A076 148 LOGICAL TECHNICAL SERVICES CORP VIENNA VA F/G 14/5
AUTOMATIC FEATURE EXTRACTION: AN ANNOTATED BIBLIOGRAPHY.(U)
MAY 79 DAAK70-78-C-0195
UNCLASSIFIED ETL-0189 NL

1 OF 5
AD A076148

LEVEL II

ETL-0189

AD A076148

AUTOMATIC FEATURE EXTRACTION

AN ANNOTATED BIBLIOGRAPHY

Logical Technical Services Corporation
311 Maple Avenue West
Vienna, Virginia 22180

DDC
RECEIVED
NOV 5 1979
E

May 1979

DDC FILE COPY

Approved for Public Release
Distribution Unlimited

Prepared for

U.S. Army Engineer Topographic Laboratories
Fort Belvoir, Virginia 22060

79 11 05 047

Destroy this report when no longer needed.
Do not return it to the originator.

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

The citation in this report of trade names of commercially available products does not constitute official endorsement or approval of the use of such products.

(19)

(18) ETL-0189

(10)

(6) AUTOMATIC FEATURE EXTRACTION :

An Annotated Bibliography.

(9) Contract rept. 28 Sep 78-30 May 79.

Logical Technical Services Corporation
311 Maple Avenue West
Vienna, Virginia 22180

DDC
RECEIVED
NOV 5 1979
E

(11) May 1979

(12) 410

(15) DAAK70-78-C-0195

Approved for Public Release
Distribution Unlimited

Prepared for

U.S. Army Engineer Topographic Laboratories
Fort Belvoir, Virginia 22060

411 446

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ETL-0189	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) AUTOMATIC FEATURE EXTRACTION: AN ANNOTATED BIBLIOGRAPHY		5. TYPE OF REPORT & PERIOD COVERED Contract Report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)		8. CONTRACT OR GRANT NUMBER(s) DAAK70-78-C-0195
9. PERFORMING ORGANIZATION NAME AND ADDRESS Logical Technical Services Corporation 311 Maple Avenue West Vienna, Virginia 22180		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer Topographic Laboratories Fort Belvoir, Virginia 22060		12. REPORT DATE May 1979 13. NUMBER OF PAGES 404
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Aerial Photographic Interpretation	Automatic Compilation
Airphoto Interpretation	Automatic Detection
Automated Cartography	Automatic Feature Extraction
Automated Map Compilation	Automatic Interpretation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An annotated bibliography was prepared, consisting of reports, papers, articles, proceedings, and significant collections dealing with Automatic Feature Extraction from continuous tone imagery, in order to meet the research and operational needs of workers responsible for topographic mapping and preparation of military geographic information (MGI). A listing of forty-two key words was compiled for the bibliographic search, which was limited to unclassified work conducted in the United States and abroad from 1970 to the present.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

19. continued

Cartographic Feature Extraction
Change Detection
Color Edge Detection
Digital Image Processing
Edge Detection
Feature Recognition
Feature Selection
Feature Tracking
Geographic Data Bases
Geographic Knowledge Sources
Geologic Interpretation
Image Analysis
Image Enhancement
Image Processing
Image Science
Image Signal Processing
Image Transforms
Image Understanding
Machine Perception
Object Enhancement & Extraction
Optical Image Processing
Pattern Classification
Pattern Recognition
Picture Processing
Raster Devices
Reconnaissance Systems
Relaxation
Remote Sensing
Scene Analysis
Scene Interpretation
Scene Segmentation
Situation Recognition
Surveillance Science
Symbolization

20. continued

Twenty-one data bases were searched, as well as other pertinent bibliographic references. Some 12,000 to 15,000 abstracts were obtained, examined, and culled. The abstracts were supplied by the author(s) or by data base editors; some abstracts were edited by project personnel for clarity or to achieve a manageable text length. The bibliographic entries are categorized in a separate index according to the specific techniques and methods being reported. The rationale for the categorization is explained. A personal author index is supplied. Collections are excluded from the author and category indexes, since the scope of this material does not lend itself to categorization.

PREFACE

This document is a compilation of reports, papers, articles, and books, dealing with Automatic Feature Extraction from continuous tone imagery, performed under Contract No. DAAK70-78-C-0195 by Logical Technical Services Corporation, 311 Maple Avenue, West, Vienna, Virginia, for the U.S. Army Engineer Topographic Laboratories (USAETL), Ft. Belvoir, Virginia. The work described herein was conducted in the United States and abroad from 1970 to the present, and is limited to unclassified material.

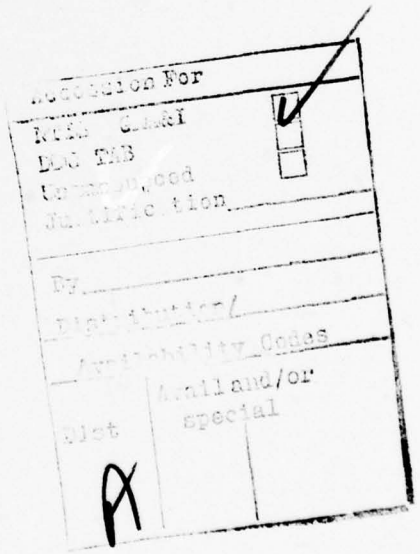


TABLE OF CONTENTS

Para.		Page
	REPORT DOCUMENTATION PAGE (DD Form 1473)	
	PREFACE	i
1.	INTRODUCTION	3
1.1	Purpose of the Document	3
1.2	Scope of the Document	3
2.	ORGANIZATION AND USE OF THE DOCUMENT	5
2.1	Classification Scheme	5
2.1.1.	Definitions	6
2.2	Data Bases Searched	7
2.2.1	Handsearch	7
3.	BIBLIOGRAPHIC ENTRY SCHEME	8
3.1	Analysis of Bibliographic Entry	8
	BIBLIOGRAPHIC ENTRIES	15
4.	COLLECTIONS	361
	CATEGORY INDEX	389
	PERSONAL AUTHOR INDEX	393

LIST OF TABLES

		Page
TABLE 1.	CLASSIFICATION SCHEME	9
TABLE 2.	KEY WORDS SEARCHED	10
TABLE 3.	DATA BASES SEARCHED	11
TABLE 4.	PERIODICALS AND JOURNALS SEARCHED	12
TABLE 5.	BIBLIOGRAPHIES SEARCHED	14

1. INTRODUCTION

Preparation of this bibliography was begun on 28 September 1978 and completed on 30 May 1979, an elapsed period of eight months. The work was carried out by a team of library researchers familiar with the many data bases in current use. The classification of the bibliographic entries was completed and reviewed by a remote sensing specialist familiar with U.S. Army mapping and military geographic information (MGI) requirements.

1.1 Purpose of the Document. This document is intended as a compilation of significant up-to-date work (from 1970 to the present) in the field of automatic feature extraction from continuous tone imagery. The entries, which include reports, papers, articles, books, proceedings, collections and texts, are intended for use by both researchers and operational workers concerned with the development of a fully automatic system for use in the extraction of mapping (topographic) and military geographic information (MGI) from the large suite of currently available remote sensor systems. A fully automatic system is one that receives, processes, and extracts data within ordained parameters with no human intervention except for initial system programming. For the purpose of this bibliography, "Automatic Feature Extraction" is defined as automation of image interpretation from continuous tone imagery in either photographic or digital form.

1.2 Scope of the Document. The intent of this document is to provide selected information relevant to ETL's Geographic Sciences Laboratory requirements for accelerating the production of timely MGI and mapping material to meet the needs of the Field Armies.

The initially described requirement called for the consideration only of work applicable to true automation; human inter-

active and computer-assisted techniques were not to be considered except where human interaction is necessary for initial programming of an automatic system.

However, it was discovered that, given these constraints, few such truly automated systems were to be found in the literature examined. Most of the research and pragmatic work reviewed engages only parts of a "truly automatic system." Thus, in terms of the definition of the automatic system as cited in paragraph 1.1 (above), it was agreed that pertinent references dealing with segments of systems -- from imagery acquisition through the development of thematic graphics and textual documents -- would be included. This necessitated expansion of the classification system, thereby lending a greater element of completeness and usability to this document as a viable and up-to-date bibliographic reference on the subject.

2. ORGANIZATION AND USE OF THE DOCUMENT

This section describes the methods and rationale used by the researchers in the classification scheme and the various data base systems queried; the components of the listed entries are described in section 3.

2.1 Classification Scheme. The classification scheme for bibliographic compilation, as defined in the initial work statement, required expansion to insure that the finished product would be as comprehensive and useful as possible. The need for a greater latitude in selecting material for inclusion became evident to the researchers after the second culling process. It was noted that:

a. certain documents fell into a category that was peripheral to the main groupings, yet appear to be useful to either the serious or casual researcher;

b. other documents are distinctly related to the principal classifications but are of marginal potential usefulness to researchers in solving MGI and mapping problems;

c. still other documents, such as special collections, proceedings, and texts, all containing summary and overview papers, are also of use in an exhaustive investigation of the subject field.

The classification scheme, as refined after culling the prospective entry material, is listed in Table 1 and further defined in paragraph 2.1.1. (below). The definition of the classification scheme is intended to lead to an understanding of the methodology of the researchers in selecting, culling, and classifying each of the entries. It further provides a preliminary qualitative basis for judging the overall usefulness of a specific document.

2.1.1. Definitions. In order to effectively glean the bibliographic entries for this document, it was necessary to first establish a set of working definitions for the several techniques and methods associated with automatic feature extraction. The definitions cited below are composites of several standard references.

a. Analog Techniques - Those methodologies, based on the principle of measuring, that relate to the presentation of data by continuously variable physical quantities such as voltages, currents, etc.

b. Digital Techniques - Those methodologies relying on the principle of counting as opposed to measuring, and providing a readout in numerical digits.

c. Hybrid Techniques - Those methodologies comprising a system that combines analog and digital techniques.

d. Optical Techniques - Those methodologies making use of light-sensitive devices to acquire information for a computer.

e. Miscellaneous Techniques - (i) Involving one or more of the foregoing techniques in a single system; (ii) a classification assigned to those techniques and methods of peripheral importance to the subject, but of sufficiently apparent significance to warrant inclusion; (iii) includes collections of papers, reports, and other materials of importance to the subject, usually in book form; (iv) those documents whose abstracts were insufficient in detail to allow precise categorization, but where the title is of obvious significance, where the set of descriptors and key words is germane, or where the author's work is generally known to be relevant.

2.2 Data Bases Searched. With the assistance of the Technology Applications Center, University of New Mexico, Albuquerque, and the New England Research Application Center, University of Connecticut at Storrs, as well as work conducted by LTS personnel, the data bases shown in Table 3 were searched for appropriate annotated references. A listing of the key words used in the search appear in Table 2.

2.2.1. Handsearch. An examination and selection of pertinent holdings in the libraries of the U.S. Geological Survey (Reston, Virginia) and the Engineer Topographic Laboratories (Fort Belvoir, Virginia) was conducted in a search for periodicals and bibliographies containing references dealing with automatic feature extraction. Listings of the materials searched are in Tables 4 and 5. Material gathered in this way is coded "Handsearch" on the bibliographic entries.

3. BIBLIOGRAPHIC ENTRY SCHEME

Each bibliographic entry was examined for applicability and categorized by index number according to the techniques to which it relates. The entries are arranged alphabetically by principal author and coded with the data base from which they were extracted. A personal author index is provided to allow quick access to the represented works of a particular researcher.

3.1 Analysis of Bibliographic Entry. Each entry presents essential information in the following order:

Principal Author
Supporting Author(s) - if any
Date of Publication
Title of Entry
Nature of Entry - If the entry is a report filed directly into a data base, contract and/or report numbers will be indicated in parentheses. Entries appearing in journals or other publications will be recognized by "in" followed by the name of the publication; location and dates of conferences, and volume, issue, and page numbers or length are included where available.
Sponsors/Performing Organizations - The sponsors and performing organizations for the work described are listed in parentheses on the last line of the entry, when such information is available.
Abstract - The abstract provides a summary of the work conducted. In most cases, the author or data base abstract is provided.
Data Base Code - The source for listed material is given below the abstract. Copies of the original item or further information pertaining to the entry may be obtained from the source(s) listed. (See Table 4)

TABLE 1. CLASSIFICATION SCHEME

Analog Techniques

Digital Techniques

Hybrid Systems

Optical Techniques

Miscellaneous Techniques and Systems

Miscellaneous Techniques and Systems is further divided into the categories listed below:

General

Analog

Digital

Hybrid

Optical

TABLE 2. KEY WORDS SEARCHED

1. Aerial Photographic Interpretation
2. Airphoto Interpretation
3. Automated Cartography
4. Automated Map Compilation
5. Automatic Compilation
6. Automatic Detection
7. Automatic Feature Extraction
8. Automatic Interpretation
9. Cartographic Feature Extraction
10. Change Detection
11. Color Edge Detection
12. Digital Image Processing
13. Edge Detection
14. Feature Recognition
15. Feature Selection
16. Feature Tracking
17. Geographic Data Bases
18. Geographic Knowledge Sources
19. Geologic Interpretation
20. Image Analysis
21. Image Enhancement
22. Image Processing
23. Image Science
24. Image Signal Processing
25. Image Transforms
26. Image Understanding
27. Machine Perception
28. Object Enhancement & Extraction
29. Optical Image Processing
30. Pattern Classification
31. Pattern Recognition
32. Picture Processing
33. Raster Devices
34. Reconnaissance Systems
35. Relaxation
36. Remote Sensing
37. Scene Analysis
38. Scene Interpretation
39. Scene Segmentation
40. Situation Recognition
41. Surveillance Science
42. Symbolization

TABLE 3. DATA BASES SEARCHED

		Bibliographic Entry Coding*
1.	American Petroleum Institute	API
2.	Central Intelligence Agency (U)	CIA
3.	Comprehensive Dissertation Index	CDI
4.	Defense Documentation Center	DDC
5.	Engineering Index	COMP or EIX
6.	Enviroline	ENVIROLINE
7.	Frost & Sullivan Defense Market Measures	FS
8.	American Geological Institute	AGI
9.	Institute of Electrical & Electronic Engineers	INSPEC
10.	Institute for Scientific Information	SCISEARCH
11.	Lockheed Missiles & Space Company	DIALOG
12.	Maritime Information Research	MIR
13.	Meteorological & Geoastrophysical Abstracts	MGA
14.	National Agricultural Library	AGRICOLA
15.	National Aeronautics & Space Administration	NASA
16.	National Technical Information Service	NTIS
17.	Oceanic Abstracts	OA
18.	Smithsonian Science Information Exchange	SSIE
19.	Systems Development Corporation	ORBIT
20.	U.S. Department of Agriculture (Current Research Information System)	USDA
21.	American Geological Index	GEOREF

*Letter coding appearing at the end of abstracts indicating data base source.

TABLE 4. PERIODICALS AND JOURNALS SEARCHED

		Bibliographic Entry Coding
1.	American Cartographer	(nc)*
2.	American Geophysical Union Transactions	(nc)
3.	Applied Optics	(nc)
4.	Army Research and Development	(nc)
5.	Association of American Geographers, Annals	(nc)
6.	Bell System Technical Journal	(nc)
7.	Canadian Geographer	(nc)
8.	Canadian Journal of Earth Sciences	(nc)
9.	Cartographic Journal	(nc)
10.	Computer Graphics and Image Processing	(nc)
11.	Computers and Geosciences (last issue, 1978, No. 1)	(nc)
12.	Computers and Graphics (last issue, 1978, No. 1)	(nc)
13.	Current Geographical Publications (to Dec. 1976)	(nc)
14.	GEO Abstracts - G, Remote Sensing	GEO-G
15.	GEO Abstracts - A, Geomorphological	(nc)
16.	GEO Abstracts - B, Biogeography, Climatology, Cartography)	(nc)
17.	Geodesy and Aerophotography (Translated from Russian)	(nc)
18.	Geological Society of America, Bulletin	(nc)
19.	Geotimes	(nc)
20.	IBM Journal of Research and Development	(nc)
21.	IEEE Proceedings	(nc)
22.	IEEE Spectrum	(nc)
23.	Journal of Forestry	(nc)
24.	Journal of Geography	(nc)
25.	Journal of Geology	(nc)
26.	Journal of Geophysical Research (Red)	(nc)

*Indicates no coding; no material taken directly from these publications.

TABLE 4 (cont'd.)

27.	Journal of Tropical Geography (to 1975)	(nc)
28.	Optical Engineering	(nc)
29.	Optical Society of America, Journal	(nc)
30.	Optics and Laser Technology	(nc)
31.	Optics and Spectroscopy (USSR - translations)	(nc)
32.	Pattern Recognition	(nc)
33.	Photogrammetria	(nc)
34.	Photogrammetric Engineering and Remote Sensing	(nc)
35.	Photogrammetric Record	(nc)
36.	Professional Geographer	(nc)
37.	Remote Sensing of the Environment	(nc)
38.	Soil Science	(nc)
39.	Soil Science Society of America, Journal	(nc)
40.	Special Libraries Association, Geography and Map Division	(nc)
41.	Surveying and Mapping	(nc)

TABLE 5. BIBLIOGRAPHIES SEARCHED

		Bibliographic Entry Coding
1.	Groom, D.W., 1976, Pattern Recognition, Vol. I, 1964-June 1975 (A Bibliography with Abstracts), NTIS/PS-76/0608, 190 pp.	ERTS-BIB
2.	Hundemann, A.S., 1978, Instrumentation and Data Processing Used in Earth Resources Technology Satellites (ERTS), Vol. II, 1976-1977 (A Bibliography with Abstracts), NTIS/PS-78/0070, 152 pp.	ERTS-BIB
3.	Reimherr, G.W., 1978, Pattern Recognition and Image Processing, Vol. III, August 1977 - July 1978 (A Bibliography with Abstracts), NTIS/PS-78/0846, 150 pp.	ERTS-BIB
4.	Hodge, D.C., and H.E. Webb, 1976, Automatic Pattern Recognition Research in the United States, U.S. Army Human Engineering Laboratory Rept. RSG-4-3A, Part 1; Part 2, Projects Supported by Other Sources.	HEL-RSG
5.	Dellwig, L.F., et al, 1975, Use of Radar Images in Terrain Analysis, An Annotated Bibliography, 318 pp. Rept. No. ETL-00245; RSL Tech. Rept. 288-2, NTIS/AD-A020 598.	RADAR BIB
6.	Vogel, T.C. and E.J. Books, 1977, A Selected Bibliography of Corps of Engineers Remote Sensing Reports, August 1977, 226 pp., Rept. No. ETL-0126, NTIS/AD-049/351.	ETL
7.	Odle, S.M., 1978, Bibliography of In-House and Contract Reports, Supplement 6, April 1978, 85 pp., Rept. No. ETL-0143, NTIS/AD-055 468.	ETL
8.	Books, E.J., 1979, Bibliography of In-House and Contract Reports, Supplement 7, April 1979, 69 pp., Rept. No. ETL-0180.	ETL

ADRIEN, P.-M. and V.C. VANDERBILT, 1977, Techniques for Estimating Scales and Areas for LANDSAT Data, (Rept. No. LARS-TR-081777), 8 pp.
(Purdue University, West Lafayette, Ind.)

Abstract - This technical report describes mathematically the scaling processes used in both optical and digital techniques. The following numerical properties of each method are summarized as a function of scale in two tables: LANDSAT pixels/square centimeter of image, surface area represented by each square centimeter of image (in hectares, acres, and square kilometers), number of pixels represented by each displayed data point, and surface area represented by each displayed data point (in hectares, acres, and square kilometers).

GEO-G

A-2

AEPLI, T., J. BROOKS, A. CARAFIDES, W. DALLAM, A. PARK and D.M. SMITH, 1978, LANDSAT D: Corps of Engineers Interface with Advanced NASA Ground Systems Study, (Contr. No. DAAK70-77 C 0237; Rept. No. ETL-0151, AD-A059 628, GE-78SDXXXX), 147 pp.
(General Ecectric Space Div., Beltsville, Md.)

Abstract - The study was designed to determine and analyze alternative interface with the LANDSAT D ground data distribution system. The requirements for data needed to meet the demands of the Civil Works Operation were identified and defined, then worded as criteria for structuring alternative system options. Perishability of the data volumes required in each district was a key issue. LANDSAT D data path was investigated in terms of these data needs, leading to identification of access paths and data availability. A characterization of the media of data transmission was provided. This report discusses the parameters that must be considered to effectively evaluate the alternatives available to the COE for interfacing with the LANDSAT D data system.

ETL

A-2a

AGGARWAL, J.K., 1977, Computer Recognition of Scenes Through Color and Motion, (Contr. No. ENG74-04986 A02; Rept. No. GSE 4640 3).
(Univ. of Texas, School of Engineering, Austin, Tex.)

Abstract - This research program deals with the use of computers in pattern recognition and scene analysis. Experimental, analytical and computational research will focus on software as well as hardware aspects of machine recognition. The integrated program of research includes computer recognition of motion and objects in motion, applications of automatic recognition techniques to aerial photographs, feature extraction from visual scenes via color, and the formulation and evaluation of nonparametric methods of classification. The overall objective of the research is to develop theoretical and experimental tools for computer recognition of objects, scenes and the occurrence of visual events. This is a continuation of research previously supported under NSF grant ENG-7404986.

SSIE

AGGARWAL, J.K., 1978, Automatic Recognition and Tracking of Objects, (Contr. No. DF046640; AF0SR-3109-77; Rept. No. GQF 46640 1)
(University of Texas, School of Engineering, Austin, Tex.)

Abstract - The development of Air Force weapon systems is becoming increasingly dependent on the real-time automatic detection, identification, and tracking of targets. At present, the ability of machines to perceive their environment is very limited. Current pattern recognition systems are capable of only identifying objects with simple contours or identifying a very limited set of target signatures. This effort will advance the Air Force capability in detecting, identifying, and tracking targets. The overall objective of this research is to develop computational and experimental tools for the analysis of aerial color photographs of a complex scene containing objects which are small, moving, and possibly occluding one another. The research program includes the extension of the existing scene-analysis algorithms to the recognition of curved objects in a scene, the study of the role of motion in order to enable the application of the recognition system to real situations like detecting and tracking of objects, and the use of color information for extracting meaningful objects from the background of the given scene as well as for detecting and tracking the objects from the aerial color imagery.

SSIE

A-4

AGGARWAL, J.K., and R.O. DUDA, 1975, Computer Analysis of Moving Polygonal Images, in IEEE Transactions on Computers, vol. C24, no. 10, pp. 966-976

Abstract - A general mathematical model is developed as an idealization of the problem of determining cloud motions from satellite pictures. The model consists of superimposed planes of rigid moving polygons. The problem is to determine from a sequence of scenes the linear and angular velocities of the figures and to decompose the scene into its component figures. Study of the model reveals a number of fundamental relations that form the basis for an analysis program. In particular a systematic analysis is given of the topological changes that can occur when overlapping figures move together or apart. A computer program based on these results is described and experimental results are presented.

GEO-G

AGRAWALA, A.K., and A.V. KULKARNI, 1977, A Sequential Approach to the Extraction of Shape Features, in Computer Graphics and Image Processing, vol. 6, no. 6, pp. 538-557.

Abstract - Most shape feature extraction techniques require enormous computing resources. This paper presents a framework for the sequential processing of an image which can be used for extracting a variety of shape features, making only one pass over the image. In addition to the extraction of simple features, such as perimeter and area, the paper also presents algorithms which can be used to extract complex features based on 'necks' and segmentation of the boundary.

GEO-G

ALBUQUERQUE, E.J., 1977, Earth Resources Management System for Analyzing Remotely Sensed Data, in Proceedings of the 24th International Electronics Congress, Rome, Italy, Mar. 28-30, 1977, pp. 33-40. (IBM Public Sector Industry Center, Brussels, Belgium)

Abstract - Earth resources management, a software system for the analysis of remote sensing data from LANDSAT satellites, is described. The Executive routine of the software system, which uses a menu-oriented method, is examined; image loading, image manipulation and display, and image creation applications are discussed. The registration application of the system, which allows the user to remove image distortions, correlate data from different sensor types, and conduct multi-temporal analyses of the same scene, is considered. In addition, the pattern recognition application of the system, a set of programs which performs multivariate analysis of imagery data, is mentioned.

NASA

ALGAZI, R., 1972, Digital Facility for Handling and Processing Remotely Sensed Earth Resources Data, in ITS, An Integrated Study of Earth Resources in the State of California Using Remote Sensing Techniques, (see N73-14361 05-13), 30 pp.
(University of California, Dept. of Electrical Engineering and Computer Sciences, Davis, Calif.)

Abstract - Details of plans for developing a digital image processing facility to handle remote sensing data are reported. Also given are programs for data acquisition and handling, systems for use in programming various digital image processing tasks, and algorithms for feature enhancement.

NASA

A-8

ANDERSON, D.E. and P.F. STEPLER, 1975, Rotate and Scale ROTSAL Program for Cartographic Application, 1 reel magnetic tape, (Rept. No. PB-244 903/1) (Central Intelligence Agency, Office of Joint Computer Support, McLean, Va.)

Abstract - The Rotate and Scale ROTSAL Program is an IBM System 360 Fortran program for cartographic application which accepts as input the raw digitized X-Y coordinate data, performs several automatic map editing functions, and outputs data in the graphic data format. The program also allows for automatic I/O error recovery from illegal characters of incomplete records in the raw digitized map data. The automatic map editing functions are: rotate the data through an angle determined by the position of the three corners of the map; scale calibrate the data from digitizer measurements; offset and shift the data to an origin of 0,0; eliminate duplicate points; check the distance between consecutive data points and either discard the point, or create additional points between the two values; close lines for islands and lakes; and allow for partial or complete deletion of a line. ROTSAL was developed as an aid for creating world data banks of the automap system.

NTIS

ANDRESEN, K.W., 1978, Computers-Applications to Range Resources Development and Monitoring, in IEEE 1978 Region 6 Conference Record, "Electronics for Resources Management," pp. 108-113.
(U.S. Dept. of the Interior, Bureau of Land Management, Office of Scientific Development, Denver, Colo.)

Abstract - The Bureau of Land Management is currently investigating, in a joint program with NASA, the usefulness of LANDSAT multispectral imagery for wildland vegetation inventories. The first of three study phases was conducted in the Denali area east of Mt. McKinley in Alaska in 1977. Data was collected at several levels: LANDSAT ditigal image data, aerial photography (high altitude at 60,000 ft., medium altitude at 30,000 ft., and low altitude at 1,000 ft.), and detailed ground plot observations. LANDSAT data processing involved debanding, statistical clustering of samples of the data, analysis and merging of the cluster statistics into a set of class statistics, maximum likelihood classification of the area, and verification of the classification using aerial photography and ground samples.

INSPEC

A-10

ANDREWS, H.C., R.P. KRUGER, and A.G. TESCHER, 1972, Image Processing by Digital Computer, in IEEE Spectrum, v. 9, Jul. 1972, pp. 20-32.
(University of Southern California, Los Angeles, Calif.)

Abstract - An outline is presented of various methods involving the use of digital computers in the manipulation of two-dimensional data for image-quality applications. The use of computer techniques in optical processes, communication systems, and automatic image detection is discussed, although the most promising areas of research are considered to be those involving image restoration and enhancement. Some experiments on a technique, known as pseudocolor, for generating color from black-and-white images are described. In pseudocolor generation black-and-white images represented by intensity matrices are processed and decomposed with the aid of a digital computer, where the appropriate algorithms are implemented.

NASA

ANDRUS, J. F. , C.W. CAMPBELL, and R.R. JAYROE, 1975, Digital Image Registration Method Using Boundary Maps, in IEEE Transactions on Computers, vol. C-24, Sept. 1975, pp. 935-940.
(National Aeronautics and Space Administration, Aero-Astrodynamics Lab., Marshall Space Flight Center, Huntsville, Ala.)

Author Abstract - A new method of automatic image registration (matching) is presented. It requires that the original single or multichannel images first be converted to binary boundary maps having elements equal to zero or unity. The method corrects for both translational and rotational errors. One feature of the technique is the rapid calculation of a pseudo correlation matrix NCOR using only integer additions. It is argued that the use of boundary maps is advisable when the data from the two images are acquired under different conditions; i.e., weather conditions, lighting conditions, etc.

NASA

A-12

ANGELICI, G.L. and N.A. BRYANT, 1977, Techniques for the Creation of Land Use Maps and Tabulations from LANDSAT Imagery, in Mapping with Remote Sensing Data, Proceedings of the 2nd Annual William T. Pecora Memorial Symposium, Sioux Falls, S. Dakota, American Society of Photogrammetry, pp. 162-171. (California Institute of Technology, Jet Propulsion Lab, Pasadena, Calif.)

Abstract - Methods for creating color thematic maps and land use tabulations, employing both LANDSAT imagery and computer image processing, are discussed. The system, the Multiple Input Land Use System (MILUS), has been tested in the metropolitan section of Dayton, Ohio. Training areas for land use were first digitized by coordinates and then transformed onto an image of white lines on a black background. This image was added to a LANDSAT image of the same area. Then multispectral classification was performed. A tape of digitized census tract boundaries was computer interfaced to yield an image of tract boundaries on a background registered to the thematic land-use map. Using a data management system, the data were then used to produce figures for the area and percent of land use in each tract. Future work is expected to convert most of the steps into interactive processing. This would greatly reduce the time needed to edit and register the data sets.

NASA

ANONYMOUS, 1977, Multispectral Data Analysis - Incomplete Report, (Rept. No. MSC-16322).

Abstract - LARSYS III-1 program is designed for remote sensing research and application. Pattern recognition and interaction data handling techniques analyze remotely sensed multispectral and multitemporal data. Primary inputs are multispectral data in image orientation.

NASA

A-14

ANUTA, P.E., 1977, Computer-Assisted Analysis Techniques for Remote Sensing Data Interpretation, in Geophysics, v. 42, no. 3, pp. 468-481.
(Purdue University, West Lafayette, Ind.)

Abstract - Applying airborne and satellite multispectral scanning radiometers, the energy sensed in each band can be used as a parameter in a computer-based, multidimensional-pattern-recognition process to aid in the interpretation of the nature of elements in the scene. Images from each band can also be interpreted visually. Visual interpretation of 5 or 10 multispectral images simultaneously becomes impractical, especially as the area studied increases; hence, great emphasis is placed on machine (computer assisted) techniques in the interpretation process. A number of other data sets are studied and integrated by digital registration with the multispectral reflectance and radiance phenomena. Topographic data, registered with four-band LANDSAT multispectral scanner (MSS) data, are being studied to determine relationships between spectral and topographic variables. Geophysical variables, including gamma-ray and magnetic data are registered and studied using the multivariate analysis approach.

COMP/GEO-G

ANUTA, P.E., 1976, Digital Preprocessing and Classification of Multispectral Earth Observation Data, in Proceedings of the 13th International Congress for Photogrammetry, Helsinki, Finland, Jul. 11-23, 1976, 31 pp. (Purdue Univ., West Lafayette, Ind.)

Author Abstract - The development of airborne and satellite multispectral image scanning sensors has generated wide-spread interest in application of these sensors to earth resource mapping. These point scanning sensors permit scenes to be imaged in a large number of electromagnetic energy bands between .3 and 15 micrometers. The energy sensed in each band can be used as a feature in a computer based multi-dimensional pattern recognition process to aid in interpreting the nature of elements in the scene. Images from each band can also be interpreted visually. Visual interpretation of five or ten multispectral images simultaneously becomes impractical especially as area studied increases; hence, great emphasis has been placed on machine (computer) techniques for aiding in the interpretation process. This paper describes a computer software system concept called LARSYS for analysis of multivariate image data and presents some examples of its application.

NASA

ANUTA, P.E., 1975, Spline Function Approximation Techniques for Image Geometric Distortion Representation -- For Registration of Multitemporal Remote Sensor Imagery, (Contr. No. NAS9-14026, NGL-15-005-112; Rept. No. NASA-CR-144397, LARS-103174), 44 pp. (Purdue Univ., Lab. for Applications of Remote Sensing, Lafayette, Ind.)

Abstract - Least squares approximation techniques were developed for use in computer aided correction of spatial image distortions for registration of multitemporal remote sensor imagery. Polynomials were first used to define image distortion over the entire two dimensional image space. Spline functions were then investigated to determine if the combination of lower order polynomials could approximate a higher order distortion with less computational difficulty. Algorithms for generating approximating functions were developed and applied to the description of image distortion in aircraft multispectral scanner imagery. Other applications of the techniques were suggested for earth resources data processing areas other than geometric distortion representation.

NASA/GEO-G

ARGUELLO, R.J., S.J. KISHNER, and H.R. SELLNER, 1972, Aerial Imagery Data Statistical Processing, Discussing Probability Density and Auto-correlation Functions and Power Spectra for Automatic Pattern Recognition, in Proceedings of the 4th Annual Electro-Optical Systems Design Conference, New York, N.Y., Sept. 12-14, 1972, 8 pp.
(Perkin-Elmer Corp., Norwalk, Conn.)

Abstract - A consideration of the possibility of measuring the statistical properties of natural scenes that are important in image data processing and handling applications. Specific statistical measures and the properties of these measures that are useful in many image and information processing applications are cited. The requirements for aerial imagery statistics from a diverse set of applications are discussed. A series of examples of the pertinent statistical quantities for a variety of aerial scenes is presented.

NASA

A-18

ARMSTRONG, A.C. and P. BRIMBLECOMBE, 1978, Experience with the Per-Point Classification Algorithms for the Mapping of Estuarine Areas from LANDSAT, in Journal of the British Interplanetary Society, v. 31, no. 1, pp. 33-36.
(Ministry of Agriculture, Fisheries, and Food, Trumpington, Cambridge, England)

Abstract - This study compares the relative efficiencies of three classification algorithms used to map estuarine areas from the computer compatible tape data from LANDSAT.

INSPEC

ASHBAUGH, J.G., 1973, Algorithm for Detecting Man-Made Objects from Aerial Reconnaissance Photographs. M.S. Thesis, (Rept. No. AD-760755, GE/EE/73-1), 107 pp.
(Air Force Inst. of Technology, School of Engineering, Wright-Patterson AFB, Ohio)

Author Abstract - An algorithm is proposed which detects and identifies man-made objects from actual aerial reconnaissance photographs. The objects are detected by cross-correlating the contour map of the digitized photograph against a generalized model for all man-made objects. This model, consisting of only three prototypes, detects objects regardless of their size, shape, and orientation. The boundary of each man-made object is then traced and represented as a parametric set of complex points. This representation is then cross-correlated with prototypes representing different general shapes in order to gain information about the size and shape of the object. This information is then combined with a logical decision process, based on some generalized rules, to classify the objects. The results of this investigation are based on a test set of six actual photographs. The procedure exhibited a detection accuracy of 71% and an identification accuracy of 87%.

NTIS/NASA

A-20

ATKINSON, R.J., B.V. DASARATHY, M. LYBANON, and H.K. RAMAPRIYAN, 1976, A Study and Evaluation of Image Analysis Techniques Applied to Remotely Sensed Data, Final Report. (Contr. No. NAS8-32107; Rept. No. NASA-CR-150041) 205 pp.
(Computer Sciences Corporation, Huntsville, Ala.)

Abstract - An analysis of phenomena causing nonlinearities in the transformation from LANDSAT multispectral scanner coordinates to ground coordinates is presented. Experimental results comparing RMS errors at ground control points indicated a slight improvement when a nonlinear (8-parameter) transformation was used instead of an affine (6-parameter) transformation. Using a preliminary ground truth map of a test site in Alabama covering the Mobile Bay area and six LANDSAT images of the same scene, several classification methods were assessed. A methodology was developed for automatic change detection using classification/cluster maps. A coding scheme was employed for generation of change depiction maps indicating specific types of changes. Inter- and intraseasonal data of the Mobile Bay test area were compared to illustrate the method. A beginning was made in the study of data compression by applying a Karhunen-Loeve transform technique to a small section of the test data set. The second part of the report provides a formal documentation of the several programs developed for the analysis and assessments presented.

NASA/NTIS/GEO-G

BABCOCK, H.C., 1978, Image Reference Set for Automated Terrain Data Extraction, (Rept. No. DAOM 8068). (Engineer Topographic Labs, Military Geographic Information Div., Ft. Belvoir, Va.)

Abstract - This project is designed to acquire a set of representative aerial images and ground truth as input for quantitative test and evaluation of hardware and software associated with automated feature extraction. A further objective is to develop the capability to duplicate the reference imagery to the required fidelity in photographic form. It is proposed to collect, document, and format in digital and/or photographic form, a reference set of images representing the range of ETL problems, terrain types, aerial sensors, image scales, imaging dates, etc.; to collect spectral reflectance data for a prioritized, finite set of features; to develop the capability to duplicate images from the reference set so that results of processing of the same image on different hardware/software systems can be compared objectively and without qualification for image condition. Reference image sets will include panchromatic, LANDSAT photography, thermal IR, radars of various frequency, etc.

DDC-WU

B-2

BAJCSY, R., and M. TAVAKOLI, 1973, A Computer Recognition of Bridges, Islands, Rivers and Lakes from Satellite Pictures, in Machine Processing of Remotely Sensed Data, Conference Proceedings, West Lafayette, Ind., Oct. 16-18, 1973, pp. 2A-54 to 2A-68. (IEEE, Inc., New York; Univ. of Pennsylvania, Philadelphia, Pa.)

Abstract - This paper describes a computer program which recognizes bridges, rivers, islands and lakes from satellite pictures. The program is structured into three basic parts: the world model, the low level operators, and the higher level program. The recognition process is conceived as a process of continuously refined verification of the hypothesized descriptions of objects. Conceptual identification of objects is used as soon as possible during the recognition process; these concepts are equipped with meanings in the three-dimensional world. Several concrete examples are presented as a demonstration of the capabilities of this program.

INSPEC/NASA

BAJCSY, R. and M. TAVAKOLI, 1976, Computer Recognition of Roads from Satellite Pictures, in IEEE Transactions on Systems, Man, and Cybernetics, v. SMC-6, no. 9, pp. 623-637.
(Univ. of Pennsylvania, Philadelphia, Pa.)

Abstract - A program which recognizes real roads, their intersections, and objects which are road-like is presented. Although the work has been strongly motivated by the real roads as they are seen from the ERTS satellite, the visual model of a road can be used for recognition of any road-like objects. This model is structured in such a way that it can handle real roads as well as rivers and streams as they are seen on satellite pictures, tracks in bubble chambers, and veins under the appropriate magnification.

COMP/NASA

B-4

BAJCSY, R. and M. TAVAKOLI, 1975, Image Filtering - A Context Dependent Process, in IEEE Transactions. Circuits and Systems, v. CAS-22, no. 5, pp. 463-474.
(University of Pennsylvania, Philadelphia, Pa.)

Abstract - This paper presents a novel approach to image filtering from the computer scene analysis point of view. It is argued that in order to build meaningful image filters, a world model is needed that includes a model of the scene, of the eye (a camera), and of the illumination. Using this description, one must recognize objects in the scene which match the description before one filters them out. It is shown that the procedure sequencing strategy is guided by the world model and by the visibility of objects on the scene. Since the filtering process involves recognition of the visual concepts of objects, it is designated 'conceptual filtering.' Similarly, since the guided strategy of the scene analysis depends on partial recognition of the scene, it is called 'conceptual focusing.' The above approach is illustrated by an example of computer recognition of bridges, rivers, lakes, and islands from ERTS satellite photographs.

INSPEC/NASA

BAJZAK, D. and C.J. LANGFORD, 1974, Sea Ice Mapping of the Labrador Pack from Satellite Imagery, in Meteorological and Earth-Resources Satellites - Special Technologies, Proceedings of the 14th International Symposium on Space, Rome, Italy, Mar. 18-20, 1974, pp. 375, 377-386.
(Memorial Univ. of Newfoundland, St. John's, Canada)

Abstract - An investigation was conducted to determine the feasibility of developing a system for mapping pack ice conditions on the basis of satellite photography. The information obtained with the aid of such a system would be useful to vessels which have to navigate in or near the Labrador Pack. Questions regarding the satellite imagery needed for such a system are considered along with details concerning the interpretation techniques, a classification of ice concentration and type, and problems of image interpretation. Attention is given to ice movement and ice field structure.

NASA

B-6

BAKER, V.R., 1973, Stream Network Analysis from Orbital and Suborbital Imagery, Colorado River Basin, Texas - Quarterly Progress Report, Aug.-Oct., 1973, (Contr. No. NAS9-13312; Rept. No. E74-10050, NASA-CR-135891-QPR-2), 155pp.
(Texas Univ., Dept. of Geological Sciences, Austin, Tex.)

Abstract - Orbital SL-2 imagery (Earth Terrain Camera S-190B), received September 5, 1973, was subjected to quantitative network analysis and compared to 7.5 minute topographic mapping (scale 1/24,000) and U.S.D.A. conventional black and white aerial photography (scale 1/22,200). Results can only be considered suggestive because it appeared in a relatively cloud-free portion of the orbital imagery. Drainage maps were drawn from the three sources digitized into a computer-compatible format, and analyzed by the water system computer program. Even at its small scale (1/172,000) and with bad haze the orbital photo showed much drainage detail. The contour-like character of the Glen Rose formation's resistant limestone units allowed channel definition. The errors in pattern recognition can be attributed to local areas of dense vegetation and to other areas of very high albedo caused by surficial exposure of caliche. The latter effect caused particular difficulty in the determination of drainage divides.

NTIS/NASA

BALASUBRAMANIAN, N. and R.D. LEIGHTY, 1975, Coherent Optics in Mapping, in Optical Engineering, v. 14, May-Jun. 1975, pp. 211-216.
(Spectra-Physics Corp., Mountain View, Calif.; Army Engineer Topographic Laboratories, Fort Belvoir, Va.)

Abstract - Potential applications of coherent optics in the field of topographic mapping are reviewed, including optical correlators for mensuration, measurements in holographic stereomodels, holographic memories, pattern recognition, optical modulators, and image processing. The motivation for applying coherent optics to topographic mapping is outlined.

NASA

B-7a

BALASUBRAMANIAN, N. and P.S. CONSIDINE, 1978, High Resolution Optical Power Spectrum Analyzer. Final Report, (Contr. No. DAAK70-77-C-0046; Rept. No. ETL-0127, AD-A051 845, EC/2106801-FR), 83 pp.
(Eikonix Corp., Burlington, Mass.)

Abstract - The High Resolution Optical Power Spectrum Analyzer (HOPS) was conceived as a better approach to a large volume optical power spectrum (OPS) scanning of imagery. This approach enables conventional OPS measurement coupled with simplified parallel optical film sampling, rather than film scanning. The HOPS is a coherent optical system that lends itself to such applications as pattern recognition, feature extraction and image assessment. Custom configuration of HOPS enables optimum use of off-the-shelf scanning photodiode arrays and adaptation to specific film scanning and spectrum sampling requirements. This work demonstrates the basic metric equivalence between HOPS and conventional OPS, as well as the advantages of the HOPS configuration for OPS measurement. After evaluation of several configurations of HOPS, a design using linear, self-scanned photodiode arrays with parallel optical trains is recommended. Detailed analysis and measurements support HOPS as a highly practical approach to OPS scanning.

ETL

B-8

BALDRIDGE, P.E. et al, 1975, Ohio's Statewide Land Use Inventory. An Operational Approach for Applying LANDSAT Data to State, Regional and Local Planning Programs, in NASA Earth Resources Survey Symposium, v. 1-C, Jun. 1975, pp. 1541-1552.
(Bendix Aerospace Corp., Ann Arbor, Mich.; Ohio Dept. of Economic and Community Development, Columbus, Ohio)

Author Abstract - The programmatic, technical, user application, and cost factors associated with the development of an operational, statewide land use inventory from LANDSAT multispectral data are described. The LANDSAT multispectral data are subjected to geometrical and categorical processing to produce map files for each of the 200 fifteen (15) minute quads covering Ohio. Computer compatible tapes are rescanned to produce inventory tapes which identify eight (8) level I land use categories and a variety of level II categories. The inventory tapes are processed through a series of ten (10) software programs developed by the state of Ohio. The net result is a computerized inventory which can be displayed in map or tabular form for various geographic units, at a variety of scales and for selected categories of usage. The computerized inventory data files are applied to technical programs developed by the various state agencies to be used in state, regional, and local planning programs.

NASA

BARNEA, D.I. and H.F. SILVERMAN, 1972, A Class of Algorithms for Fast Digital Image Registration, in Computer Methods in Image Analysis, ed. J.K. Aggarwal, R.O. Duda and A. Rosenfeld, 1977, pp. 23-30; reprinted from IEEE Transactions on Computers, C-21, 1972, pp. 179-186.

Author Abstract - The automatic determination of local similarity between two structured data sets is fundamental to the disciplines of pattern recognition and image processing. A class of algorithms, which may be used to determine similarity in a far more efficient manner than methods currently in use, is introduced in this paper. There may be a saving of computation time of two orders of magnitude or more by adopting this new approach. The problem of translational image registration, used for an example throughout, is discussed and the problems with the most widely used method-correlation explained.

GEO-G

B-10

BARROW, H.G., 1976, Interactive Aids for Cartography and Photo Interpretation, Semiannual Technical Rept., 12 Nov. 76 - 12 May 77, (Contr. No. DAAG29-76-0057, ARPA Order-2894; Rept. No. AD-A043 418), 37 pp. (Stanford Research Inst., Menlo Park, Calif.)

Abstract - This report describes the status of the SRI Image Understanding project at the end of twelve months. The central scientific goal of the research program is to investigate and develop ways in which diverse sources of knowledge may be brought to bear on the problem of interpreting images. The research is focused on the specific problems entailed in interpreting aerial photographs for cartographic or intelligence purposes. A key concept is the use of a generalized digital map to guide the process of image interpretation.

DDC

BATSON, R.M., K. EDWARDS, and E.M. ELIASON, 1976, Synthetic Stereo and LANDSAT Pictures, in Photogrammetric Engineering and Remote Sensing, v. 42, no. 10, 1976, pp. 1279-1284.

Author Abstract - Digital image processing techniques can be used to introduce stereoscopic parallax into a composite data set consisting of digital terrain elevation data and corresponding digital television images. The technique was developed with part of a LANDSAT scene and digital elevation data provided by the Defense Mapping Agency. The geometry of the LANDSAT image was digitally modified to coincide with that of the elevation data set. Parallax was introduced as a simple linear function of terrain height at each picture element, to produce a stereoscopic mate to an image which has essentially no parallax.

GEO-G

B-12

BAUMGARDNER, M.F., D.A. LANDGREBE, and H.H. KRAMER, 1972, Automatic Identification of Land Uses in Milwaukee, Wisconsin Using ERTS-1 Imagery, (Contr. No. NAS5-21785; Rept. No. E72-10307, NASA-CR-129556), 2 pp. (Purdue Univ., Lafayette, Ind.)

Abstract - Spectrally, thirteen classes of ground cover were identified within Milwaukee County: five classes of water, grassy open areas, beach, two classes of road, woods, suburban, inner city, and industry. A distinct concentric pattern of land use was identified in the county radiating outward from the central business district. The first ring has a principal feature, termed the inner city, which is indicative of the older part of the county. In the second ring, the land use becomes more complex, consisting of suburban areas, parks, and varied institutional features. The third general ring consists primarily of open, grassy land, with scattered residential subdivisions, wood lots, and small water bodies. The five classes of water identified suggest differences in depth, turbidity, and/or color. A number of major roads were identified. Other spectrally identifiable features included the larger county parks and larger cemeteries.

NASA/NTIS

BAYMA, R.W., R.L. JORDAN, and B.N. MANNING, 1977, A Survey of SAR Image-Formation Processing for Earth Resources Applications, in ITS Proceedings of the 11th International Symposium on Remote Sensing of the Environment, v. 1, pp. 137-159.
(Goodyear Aerospace Corp., Litchfield Park, Ariz.)

Author Abstract - Currently there is considerable interest in active microwave sensors for earth resources applications, such as the SEASAT-A radar. However, to obtain spatial resolutions comparable to optical sensors at radar frequencies, sophisticated image formation processing techniques must be applied to the raw data. Processing requirements for non-coherent optical and coherent radar imaging systems are compared. The image formation processing requirements for synthetic aperture radar (SAR) systems are discussed. Both optical and digital techniques are addressed, and examples of hardware and imagery for each processing technique are presented.

NASA/NTIS

B-14

BEAUMONT, T.E., P.J. BEAVEN, and J.W. DOWLING, 1977,
The Application of Remote-Sensing Survey Techniques in Road Engineering, (Contr. No. 087634; Rept No. BI 87634)
(Ministry of Transport, Transport and Road Research Lab., Crowthorne, England)

Abstract - This project involves the following: (1) evaluation of the application of remote-sensing survey techniques to the planning and site-investigation stages of road construction. Emphasis is on the use of multispectral photographs taken from light aircraft for identification of unstable ground and other problems in mountainous terrain, (2) evaluation of satellite imagery as a basis for engineering soil mapping, route location and transport planning in regional development, (3) investigation of advanced image interpretation techniques for analysis of remote-sensing imagery and satellite computer-compatible tapes. Work will include studies of photographs and imagery covering areas in Nepal, Africa, South America and Southeast Asia.

SSIE

BENTON, J.R., 1978, Data Extraction Using Experimental Pockel's Readout Optical Modulator (PROM) Device, (Rept. No. DAOM 8112).
(Army Engineer Topographic Labs., Research Inst., Ft. Belvoir, Va.)

Abstract - The objective of this research is to identify, define, and conduct research having potential applicability to advanced military topographic systems of the future. The Pockel's Readout Optical Modulator (PROM) device is a real-time read/write/erase optical modulator that will be investigated in coherent optical systems for application to automated data extraction from aerial photography by correlation matched filter techniques.

DDC-WU

B-16

BERNSTEIN, R., 1973, Digital Processing of ERTS-1 Imagery. Progress Report, Dec. 1, 1972 - Feb. 1, 1973, (Contr. No. NAS5-21716; Rept. No. E73-10080, NASA-CR-130 278), 4 pp.
(International Business Machines Corp., Federal Systems Center, Gaithersburg, Md.)

Abstract - Experimentation was conducted to evaluate the performance of the sequential similarity detection algorithm (SSDA) to detect and locate ground central points (GCP) automatically using MSS data. Recent experiments with ERTS data having a temporal separation of from 17 to 72 days between the search area and the GCP have shown that the algorithm can find the GCP's and with an overall probability of 88%. Band 5 appears to give the best results. A modified reseau detection algorithm has been applied to 2 RBV scenes separated by a 12 day period. The algorithm correctly located all 486 reseaus. No false reseaus were located in a companion experiment. Changes in apparent reseau position, due to camera characteristics, were never greater than 3 picture elements in either axis. The positional error of a geometrically corrected image has been predicted by the use of an APL program. The maximum deviation of the GCP's from true UTM coordinate position was computed to be 190 meters. The RMS positional error of all GCP's was 106 meters. Further refinement of the algorithm is expected to reduce errors.

NASA/NTIS

BERNSTEIN, R., 1974, Scene Correction (Precision Techniques) of ERTS Sensor Data Using Digital Image Processing Techniques, in NASA, Goddard Space Flight Center, 3rd ERTS-1 Symposium, v. 1, sect. B, pp. 1909-1928. (International Business Machines Corp., Federal Systems Div., Gaithersburg, Md.)

Author Abstract - Techniques have been developed, implemented, and evaluated to process ERTS return beam vidicon (RBV) and multispectral scanner (MSS) sensor data using digital image processing techniques. The RBV radiometry has been corrected to remove shading effects, and the MSS geometry and radiometry have been corrected to remove internal and external radiometric and geometric errors. The results achieved show that geometric mapping accuracy of about one picture element RMS and two picture elements (maximum) can be achieved by the use of nine ground control points. Radiometric correction of MSS and RBV sensor data has been performed to eliminate striping and shading effects to about one count accuracy. Image processing times on general purpose computers of the IBM 370/145 to 168 class are in the range of 2.9 to 3.2 minutes per MSS scene (4 bands). Photographic images of the fully corrected and annotated scenes have been generated from the processed data and have demonstrated excellent quality and information extraction potential.

NASA

B-18

BIEHL, L.L. and L.F. SILVA, 1975, Evaluation of Skylab Data for Land Use Mapping, in Journal of the Astronautical Sciences, v. 23, Apr.-Jun. 1975, pp. 121-146. (Purdue Univ., West Lafayette, Ind.)

Abstract - Skylab multispectral scanner data, digitized Skylab color IR photography, digitized Skylab black and white multiband photography, and Earth Resources Technology Satellite (ERTS) multispectral scanner data collected within a 24-hour time period over an area in south-central Indiana near Bloomington on June 9 and 10, 1973, were compared in a machine-aided land use analysis of the area. The overall classification performance results obtained with nine land use classes were: 87% correct classification using the "best" 4 channels of the Skylab multispectral scanner; 80% for the channels on the Skylab multispectral scanner, which are spectrally comparable to the ERTS multispectral scanner; 88% for the ERTS multispectral scanner; 83% for the digitized color IR photography; and 76% for the digitized black and white multiband photography. The results indicate that the Skylab multispectral scanner may yield even higher classification accuracies when a noise filtered multispectral scanner data set becomes available in the near future.

NASA

BITLER, J.R. and J.D. MARTIN, 1977, Computer Graphics Demonstration - Area Coal Availability Studies, (Rept. No. PB-267 923/156), 21pp.
(Bureau of Mines, Eastern Field Operation Center, Pittsburgh, Pa.)

Abstract - A computerized mapping system was developed by the Bureau of Mines to provide procedures for the rapid and inexpensive display of coal reserve data. Mapping system output consists of two types of maps, point distribution and contour isopleth, which can be produced for data coal analyses associated with a point location outcrop, drill core, or mine samples. These locations can be in the form of latitude and longitude or universal transverse mercator (UTM) grid coordinates. The mapping area can range in extent from as small as a single county to as large as a multi-state region. The primary advantage of this system is that it enables the display of a rapidly changing data base and computerized map generation without the intermediate steps of digitizing and overlaying to produce base maps. The mapping system is applicable to any regional mineral reserve or resource study for which point location data are available. Included are example maps of the distribution of data points and contouring for sulfur content of the upper Freeport coalbed in the western Pennsylvania demonstration area.

NTIS/NASA

B-20

BLODGET, H.W., 1978, Lithology Mapping of Crystalline Shield Test Sites in Western Saudi Arabia Using Computer-Manipulated Multispectral Satellite Data. Ph.D. Thesis, (Rept. No. GV805122), 223pp.
(George Washington Univ., Washington, D.C.)

Abstract - Two areas were selected in the Arabian Shield to provide ideal test sites for the evaluation of satellite remote sensing capabilities for geological mapping; emphasis was placed on rock descrimination using LANDSAT multispectral scanner data. The Sahl al Matran area of Northwestern Saudi Arabia was selected as the primary test site for evaluating a wide range of optical-electrical (analog) and computer (digital) classification and enhancement techniques. Two interactive, digital, multispectral classification systems were tested that respectively employed the Bayesian maximum-likelihood and parallelepiped classification algorithms. A variety of computer enhancement techniques were evaluated.

NASA

BODECHTEL, J. and R. HAYDN, 1977, Analog and Digital Processing of Multispectral Data for Geologic Application, in Remote Sensing of the Terrestrial Environment, Proceedings of the 28th Symposium, Bristol, England, Apr. 5-9, 1976, pp. 159-168.
(Zentralstelle fuer Geo-Photogrammetrie und Fernerkundung, Munich, West Germany)

Abstract - An automatic analog and digital classification for the interpretation of geological information in remote sensing imagery is described. An electronic analog processor for single or multiple images (multispectral or multitemporal) is considered; the processor accepts photographic transparencies fed into a disk memory and performs such functions as density slicing and logarithmic density stretching. Attention is also given to hybrid analog-digital processing to achieve statistical enhancement of class separability and combination of transformed data by operation in color space. Descriptive statistics, data manipulation and classification-periodicity analyses may be obtained through digital processing.

NASA

B-22

BODECHTEL, J. and R. HAYDN, 1975, Combined Digital and Analog Evaluation Techniques Under Operational Aspects - For Multispectral Band Scanner Data Processing, in Space Exploration-Conversion and Exploitation of Solar Energy, Proceedings of the 15th International Conference on Space, Rome, Italy, Mar. 17-19, 1975, pp. 35, 37-49. (Zentralstelle fuer Geo-Photogrammetrie und Fernerkundung, Munich, West Germany)

Abstract - The paper discusses the general principles of automatic classification of spectral data obtained by earth resource satellites and examines the advantages gained by special preprocessing techniques for either fully automatic interpretation or for combined analog/digital interactive processing. These preprocessing techniques are (1) enhancement of class separability by weighted linear component transformation, (2) color coding by operating in three-dimensional color space, and (3) decision making by analyzing and separating color distributions.

NASA

BODENHEIMER, R.E. and W.L. GREEN, 1972, Digital Image Processing and Interpretation of Photographic Film Data, in Scanning the Spectrum, Proceedings of the 10th Annual IEEE Region 3 Convention, Knoxville, Tenn., Apr. 10-12, 1972, pp. M4-1 to M4-5. (Univ. of Tennessee, Knoxville, Tenn.)

Abstract - Digitized computer systems capable of processing large quantities of data are discussed. The information from the various multispectral imaging sensor systems must be converted to a digital data format and stored on a convenient bulk processing medium such as disks or magnetic tape. The X-Y scanning micrometer, which is one means of converting film analog information into digital data, is described. Software can be developed for processing digitized data.

NASA

B-24

BOETTCHER, A.J. and R.M. HARALICK, 1978, Use of Thermal-Infrared Imagery in Ground-Water Investigations in Montana, (Rept. No. GU701171), 10 pp. (Geological Survey, Helena, Mont.; Kansas Univ., Lawrence, Kans.)

Abstract - Thermal infrared imagery was used to locate ground-water inflow along three streams and one lake in Montana. The thermal scanner used in May 1972, March 1973, and November 1975 was mounted in a twin-engined aircraft. On the 1973 and 1975 flights, the data were recorded in an analog format on magnetic tape in flight, later were converted to digital format, and were computer processed using an assignment of patterns to indicate differences in water temperature. Output from the image processing program was converted to a temperature map having an isotherm spacing of 0.5 C. Computerization was found to be the most efficient method to manipulate data from lakes, large rivers, and narrow sinuous streams.

NASA/NTIS

BOND, A.D., et al, 1973, Image Analysis Techniques Associated with Automatic Data Base Generation, in American Institute of Aeronautics and Astronautics, Computer Network Systems Conference, Huntsville, Ala., Apr. 16-18, 1973, 15 pp.
(National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.)

Author Abstract - This paper considers some basic problems relating to automatic data base generation from imagery, the primary emphasis being on fast and efficient automatic extraction of relevant pictorial information. Among the techniques discussed are recursive implementations of some particular types of filters which are much faster than FFT implementations, a 'sequential similarity detection' technique of implementing matched filters, and sequential linear classification of multispectral imagery. Several applications of the above techniques are presented including enhancement of underwater, aerial and radiographic imagery, detection and reconstruction of particular types of features in images, automatic picture registration and classification of multiband aerial photographs to generate thematic land use maps.

NASA

B-26

BOND, A.D. and D.T. THOMAS, 1973, Automatic Information Extraction for Land Use and Agricultural Applications, in Management and Utilization of Remote Sensing Data, Proceedings of the Symposium, Sioux Falls, S. Dak., Oct. 29-Nov. 1, 1973, pp. 257-269. (National Aeronautics and Space Administration, Marshall Space Flight Center, Computation Lab., Huntsville, Ala.)

Abstract - A description is presented of some current work in interpretation technique development for automatic computer-aided image information extraction related to various application areas, including land use mapping and agricultural survey and monitoring. In particular, the application of a fast template matching algorithm, employing the sequential similarity detection principle, to image registration, linear feature detection, and the extraction and enumeration of scene objects is discussed and illustrated.

NASA/GEO-G

BONRUD, L.O., K.W. ENSTROM, D.J. PANTON, and M.O. SCHROEDER, 1974, Analysis and Development of Digital Mapping System Software, (Contr. No. DAAK02-73-C-0287; Rept. No. AD-781 613/5; ETL-CR-74-5), 123pp.
(Control Data Corp., Digital Image Systems Div., Minneapolis, Minn.)

Modified Author Abstract - The report describes the work done in the area of digital stereo mapping under contract with the United States Army Engineer Topographic Laboratories. The philosophy and techniques developed by the Digital Image Systems Division of Control Data Corporation in the past have been applied to the design and implementation of a software system to be used in the development of algorithms that relate to the problem of digital stereo matching. The system is designed as a research tool with the basic characteristics of flexibility and simplicity incorporated into a block processing environment. The major tasks of data handling and stereo image matching are logically separate from one another and are further subdivided into versatile functional components that are easily interchangeable as new algorithms are developed.

NASA

B-28

BONRUD, L.O. and P.J. HENRIKSON, 1974, Correlation and Registration of ERTS Multispectral Imagery; By a Digital Processing Technique, (Contr. No. NAS9-13114; Rept. No. NASA-CR-134294), 127 pp. (Control Data Corp., Minneapolis, Minn.)

Author Abstract - Examples of automatic digital processing demonstrate the feasibility of registering one ERTS multispectral scanner (MSS) image with another obtained on a subsequent orbit, and automatic matching, correlation, and registration of MSS imagery with aerial photography (multisensor correlation) is demonstrated. Excellent correlation was obtained with patch sizes exceeding 16 pixels square. Qualities which lead to effective control point selection are distinctive features, good contrast, and constant feature characteristics. Results of the study indicate that more than 300 degrees of freedom are required to register two standard ERTS-1 MSS frames covering 100 by 100 nautical miles to an accuracy of 0.6 pixel mean radial displacement error. An automatic strip processing technique demonstrates 600 to 1200 degrees of freedom over a quarter frame of ERTS imagery. Registration accuracies in the range of 0.3 pixel to 0.5 pixel mean radial error were confirmed by independent error analysis. Accuracies in the range of 0.5 pixel to 1.4 pixel mean radial error were demonstrated by semi-automatic registration over small geographic areas.

NASA/NTIS

BOSMAN, E.R., E. CLERICI, D. ECKHART, and K. KUBIK, 1971, Project KARAKA. The Transformation of Points From Sidelooking Radar Images Into the Map System, Part I. Final Report, 29 pp. (Netherlands Interdepartmental Working Group on the Application of Remote Sensing, Delft, The Netherlands)

Author Abstract - A program system designed to transform side-looking radar (SLAR) images into the map system is described. The program system also includes options for automatically drawing digitized lines of the SLAR images and for performing a statistical analysis of the accuracy of the transformation.

NASA

B-30

BOSMAN, E.R., E. CLERICI, K. KUBIK, and D. ECKHART, 1973, Experience with the Program System KARIN for the Mapping of Remote Sensing Information, in Machine Processing of Remotely Sensed Data, Proceedings of the Conference, Oct. 16-18, pp. 2B-14 to 2B-24. (Rijkswaterstaat, The Hague; Netherlands International Institute for Aerial Survey and Earth Sciences, Delft, Netherlands)

Abstract - A program system was jointly developed by NIWARS and Rijkswaterstaat, The Netherlands, for the mapping of geographic detail from single or overlapping remote sensing images (sidelooking radar, infrared, A.O.). The system consists, similar to the conventional systems for aerial triangulation, of programs for strip formation, strip and block adjustment and for the plotting of the information. Examples of infrared and sidelooking radar projects are included to demonstrate the application of the system.

NASA

BOSTON, S. and L. GIDDINGS, 1976, An Eight-Neighbor Filter for LARSYS, (Contr. No. NAS9-12200; Rept. No. NASA-CR-147802, LEC-7619, JSC-10795), 46 pp. (Lockheed Electronics Co., Aerospace Systems Div., Houston, Tex.)

Author Abstract - An eight-neighbor filter was developed for the LARSYS program. It is used in cleaning zones and sharpening boundaries during the digitization of hand-painted zone maps, in making computer-based vegetation zones more homogeneous, and in classification of natural images, such as LANDSAT or other multispectral imagery.

NASA/NTIS

B-32

BOYELL, R.L. and P.A.T. WOLFGANG, 1973, A Radar Prediction System. Volume I, Final Report. (Contr. No. F30602-71-C-0344; Rept. No. PRA-U72-1309-Vol-1, AD-907 900L), 312 pp.
(Pennsylvania Research Associates, Inc., Cornwells Heights, Penn.)

Author Abstract - This report describes the techniques, procedures, and computer software developed for making radar prediction: automatically synthesized gray-scale images which predict the appearance of an airborne radar indicator (sector scan PPI) for user-imposed radar locations, operating parameters, and control settings. A radar prediction data base is formulated wherein the radar reflective properties of topographic features and target complexes may be represented in the format of the Automatic Cartographic System (ACS). Data processing operations are related by which such a data base was prepared from a particular collection of ACS source data, and the general technique of radar prediction using ACS data is discussed. Details are provided of the computer programs developed to access the data base, produce a radar map of a prescribed problem area, and prepare digital descriptions of the computed images from the radar map for presentation on a display. Radar predictions made by using these programs are exhibited in this report. ACS improvements are suggested to support the development of a radar prediction system (RPS) having tactical application.

DDC

BREEDING, K.J., 1978, Alternative Computer Architectures for System Reliability and Software Simplification, (Contr. No. DF049550; AFOSR-3400-77; Rept. No. GQF 49550 1)
(Ohio State University, School of Engineering, Columbus, Ohio)

Abstract - The complexity, volume and rate of reconnaissance and surveillance data is ever increasing. The ability to cope with this problem rests in the automation of some, if not all, of the data acquisition and analysis. Two problem areas requiring extensive effort are what attributes must be extracted from input data in order to facilitate required decision processes and what hardware architecture can best be used to extract them. This research will investigate the application of various nonconventional computer architectures to the problems of software simplification and overall system reliability. The work will be directed at four problems-the application of syntactic feature analysis to the visual pattern recognition problem involving full half tone images and partially occluded images, the application of an image array processor to the problem of image compression, investigations into a gracefully degradeable, distributed control system, and investigations into machine architecture for high speed, direct execution of high level languages.

SSIE

B-34

BRESSANIN, G., 1975, On-Board and Ground Data Processing in the Spacelab for Earth Resources, (Rept. No. DCAF E00391), 35 pp.
(Telespazio, S.p.A., Rome, Italy)

Abstract - The most promising methods for solving the system requirements are discussed with emphasis on new technologies such as optical and holographic memories. The main data processing techniques for earth resources applications are illustrated. Specific attention is paid to special purpose processors, which will extract useful information from the data in an efficient and cost-effective way.

NASA/NTIS

BRESSANIN, G. and J. ERIKSON, 1973, Data Preprocessing Systems for Earth Resources Surveys. Volume 2. Methods of Implementation, (Rept. No. ESRO-CR-296, ESTEC-1761/72), 188 pp.
(Telespazio, S.p.A., Rome, Italy; Earth Resources Survey Program, Paris, France; Environmental Research Inst. of Michigan, Ann Arbor, Mich.)

Abstract - The significant features and requirements of an operational remote sensing information system are described along with the effects of these requirements on the implementation of such a system. Problems encountered in the implementation of algorithms by means of digital, analog and hybrid computers are discussed. The major software packages available for image data processing are reviewed and aspects of data storage and retrieval are discussed. Finally, two illustrated examples of data processing systems are given - one on a multispectral scanner and the other on the coherent optical processing of geographical imagery.

NASA/NTIS

B-36

BROOKE, R.K., JR., 1976, Parallel Optical Processing to Convert Elevation Data to Slope Maps. Phase I: Theoretical Analysis Research Note, Jul. 1972-Oct. 1974, (Contr. No. DA Proj. 4AO-62112-A-854; Rept. No. AD-A01 179, ETL-RN-74-9), 24 pp. (Army Engineer Topographic Labs., Fort Belvoir, Va.)

Abstract - Given a photographic transparency with an amplitude transmittance function, T(X sub 0, Y sub 0), that is equivalent to a functional representation of elevation information, H(X sub 0, Y sub 0), for a particular geographic area, the slope information can be rapidly displayed using a coherent optical system and a one-dimensional differentiating filter. Implementation of this technique could provide an electro-optical system for the high speed conversion of elevation data to a slope map. It is concluded that slope map displays can be obtained from elevation function transparencies, though negative and positive slopes of the same magnitude are displayed identically. This is not expected to affect the utility of the output.

NASA/NTIS

BRYANT, N.A. and A.L. ZOBRIST, 1976, IBIS - A Geographic Information System Based on Digital Image Processing and Image Raster Datatype, in Proceedings of the Symposium on Machine Processing of Remotely Sensed Data, West Lafayette, Ind., Jun. 29-Jul. 1, 1976, pp. 1A-1 to 1A-7.
(California Inst. of Technology, Jet Propulsion Lab, Pasadena, Calif.)

Abstract - IBIS (Image Based Information System) is a geographic information system which makes use of digital image processing techniques to interface existing geocoded data sets and information management systems with thematic maps and remotely sensed imagery. The basic premise is that geocoded data sets can be referenced to a raster scan that is equivalent to a grid cell data set. The first applications (St. Tammany Parish, Louisiana, and Los Angeles County) have been restricted to the design of a land resource inventory and analysis system. It is thought that the algorithms and the hardware interfaces developed will be readily applicable to other LANDSAT imagery.

NASA

B-38

BRYANT, N.A. and A.L. ZOBRIST, 1978, An Image Based Information System - Architecture for Correlating Satellite and Topological Data Bases, in Proceedings of the Symposium on Data Management, Huntsville, Ala., Oct. 18-19, 1977, pp. 135-142.
(California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.)

Abstract - The paper describes the development of an image based information system and its use to process a LANDSAT thematic map showing land use or land cover in conjunction with a census tract polygon file to produce a tabulation of land use acreages per census tract. The system permits the efficient cross-tabulation of two or more geocoded data sets, thereby setting the stage for the practical implementation of models of diffusion processes or cellular transformation. Characteristics of geographic information systems are considered, and functional requirements, such as data management, geocoding, image data management, and data analysis are discussed. The system is described, and the potentialities of its use are examined.

NASA

BUCKMEIER, F.J., J. L. COLP, J. FORREST, and H.R. MARIEN, 1970, An Evaluation of Airborne Sensors for Site Selection Engineering Data Requirements. Technical Report, May 68-Nov. 69, (Contr. No. F29601-68-C-0076; Rept. No. AD-870 791), 322 pp. (Texas Instruments Inc., Dallas, Tex.)

Author Abstract - The report describes the data acquisition and evaluation of several remote sensors over three types of environment for engineering terrain data used in site selection. Extensive field and airborne data were collected at each of three sites in Texas, Louisiana, and New Mexico. The sensors used for data collection were metric photography, multiband photography, infrared scanner (8 to 14 microns), laser terrain profiler, airdroppable penetrometer, and gamma-ray spectrometer. Several operational modes were used and are described. The analyses are summarized in sections by Texas Instruments, Inc., Sandia Laboratories, and the Eric C. Wang Civil Engineering Research Facility (University of New Mexico). Recommendations for a site selection system of sensors are made.

DDC

C-1

CAMILLERAPP, J. and J. QUINQUETON, 1977, Lines Extraction from Radar Images, in Proceedings of the NATO Advanced Study Institute on Digital Image Processing and Analysis, pp. 361-372.
(Univ. of Paris, Paris, France)

Abstract - The paper describes the line detection technique for automatic digital interpretation of cartography radar images. The echoes extraction on a dark background image is discussed.

NASA

CANNON, M.W., 1978, Application of Visual System Model to Air Force Problems in Pattern Recognition, (Contr. No. DF321530; Rept. No. ZQF321530 1) (U.S. Air Force, Aerospace Medical Research Lab, Wright-Patterson AFB, Dayton, Ohio)

Abstract - A need exists in the Air Force for hardware systems that can aid and/or replace human operators in certain phases of reconnaissance imagery analysis, surveillance and target detection. The objective of this work unit is to (1) develop techniques to aid the human operator in visual detection and recognition tasks, and (2) to investigate design principles for automatic systems by which the task would be more efficiently performed without man's intervention. Two aspects of the visual man-machine interface problem will be given special emphasis. (1) Techniques will be developed for determining by a computerized procedure the confusability of cockpit display symbol sets and for designing symbol sets with minimum confusability among symbols of the set. (2) Adaptive pattern recognition techniques and the form recognition capabilities of the visual system model will be combined to investigate the enhancement and recognition of targets in reconnaissance imagery. These techniques will be used to demonstrate automatic navigation systems which can locate and identify targets from radar or visual imagery without human intervention. The form recognition capabilities of the visual system model will also be applied to the analysis of target form distortion by aircraft windscreens.

SSIE

C-3

CANNON, M.W., JR. and J.W. CARL, 1974, TERCOM Performance, Analysis and Simulation. Final Report, 19 Oct. 1972 - 14 Nov. 1973, (Rept. No. AD-783804; AMRL-TR-73-130), 71 pp.
(Aerospace Medical Research Labs., Wright-Patterson Air Force Base, Dayton, Ohio)

Abstract - A theoretical analysis of the performance of a nearest-prototype classifier (nearest in the sense of Euclidean distance) is presented as an approximate analysis of the performance of the Terrain Contour Matching Navigation System (TERCOM). The analysis is used to predict classifier performance on both artificially generated terrain with Gauss-Markov statistics and on real-world terrain. Over 150 simulation runs were performed over such terrain, having added Gauss-Markov noise (independent of the terrain process) with 6 different noise levels. Results of the simulation are presented, giving performance as a function of signal/noise ratio and as a function of terrain roughness. Measured miss-distances are also presented. The simulation also includes the performance of a nearest-prototype classifier based on mean absolute distance (the first Minkowski metric), which is the actual metric employed in TERCOM.

NASA/NTIS

CARTER, V., and J. SCHUBERT, 1974, Coastal Wetlands Analysis From ERTS MSS Digital Data and Field Spectral Measurements, in Proceedings of the 9th International Symposium on Remote Sensing of the Environment, Ann Arbor, Mich., Apr. 15-19, 1974, v. 2, pp. 1241-1260. (Environmental Research Inst. of Michigan, Willow Run Lab., Ann Arbor, Mich.; U.S. Geological Survey, National Center, Reston, Va.)

Abstract - Classification, delineation and evaluation of coastal wetlands can be made on the basis of major vegetative associations. To produce wetland maps, two vegetation-analysis look-up tables were developed for use in the ERTS analysis system. These look-up tables are based on Earth Resources Technology Satellite (ERTS) digital values in multispectral scanner (MSS) bands 4, 5, and 7 and were developed using seasonal spectral reflectance measurements from field observations. Computer-generated maps at an approximate scale of 1:20,000 were produced for the primary test site, Chincoteague Marsh, Virginia. There is a high degree of accuracy in the identification of wetland features and plant associations.

EIX

C-5

CENTRAL INTELLIGENCE AGENCY, 1977, CAM - Cartographic Automatic Mapping Program Documentation, 5th Edition, (Rept. No. PB-270 304/9SL; GC-77-10126), 138 pp. For magnetic tape, see PB-270 303; see also PB-251 390. (Central Intelligence Agency, Office of Geographic and Cartographic Research, Washington, D.C.)

Abstract - CAM is an IBM System 360 Fortran level H or G and assembly language code (ALC) program that performs a wide variety of cartographic functions. Included are 16 map projections, the universal transverse mercator (UTM) grid system, and an xy one-for-one data display routine. CAM will connect points with straight lines or circles, and draw line grids, range rings, ellipses, cones, symbols, azimuths and elevation rings. Included is a World Coastline File of 8200 points, but CAM may also be used in conjunction with World Data Bank I, a 100,000 point file separately contained on accession no. PB-223 178. A significant new feature of CAM-5th edition also allows its use in conjunction with World Data Bank II, which contains approximately 6 million points contained on 5 separate geographic area files. These geographic area files are volumes 1-5, and contain, respectively, 1--North America, 2--South America, 3--Europe, 4--Africa, and 5--Asia.

NASA

CHEN, C.H., 1975, The Automatic Analysis of Aerial Photographic Data, in Proceedings of the International Telemetering Conference, Washington, D.C., Oct. 14-16, 1975, pp. 529-535.
(Southwestern Massachusetts Univ., North Dartmouth, Mass.; Instrument Society of America, Pittsburgh, Penn.)

Abstract - The computationally effective techniques for computer processing of aerial photographic data discussed can be incorporated in a fully automated data analysis system to meet real-time on-line system requirements. The principle features of the following techniques are outlined: picture data reduction to a volume amenable to computer processing; extraction of useful features from gray-scale histograms; sequential target acquisition; threshold selection for generating a binary (two-level) picture; and Walsh power spectrum analysis, in which the Walsh power spectrum is obtained for a given picture by first taking the Walsh transform and then computing the power at each sequency component which is the sum of squares of the Walsh transform at the same sequency.

NASA

C-7

CHEN, C.H., 1975, Theory and Applications of Image Pattern Recognition, (Contr. No. AF-AFOSR-2119-71; Rept. No. EE-75-3; AD-A011 675; AFOSR-75-0795TR), 81 pp. (Southeastern Massachusetts Univ., Dept. of Electrical Engineering, North Dartmouth, Mass.; Air Force Office of Scientific Research, Arlington, Va.)

Abstract - In recent years, there has been an increasingly greater demand for automatic recognition of imagery patterns which arise in biomedical, space, military, security and vast numbers of other applications. As the computer hardware cost decreases rapidly, automatic image recognition will soom become a reality in many of these applications. Automatic image recognition is also a major step toward designing intelligent machines. In this report, a unified theory of image pattern recognition is developed which includes pattern representation, preprocessing, feature extraction and pattern classification. Computer results from aerial photograph studies are used for illustrative purposes. The theory should be useful for a wide range of imagery patterns. The problem of computational complexity which should be the primary consideration in recognition system design is carefully examined. As the imagery patterns are complicated in nature, it is recommended that both statistical and syntactic methods in pattern recognition should be used to arrive at the best solution for the specific recognition task at hand. An extensive bibliography at the end of the report provides a fairly complete view of the past efforts, approaches and applications of image pattern recognition.

NTIS/DDC

CHEN, P.-F., and W.W. SEEMULLER, 1977, High Speed Parallel Sensing Scheme, (Rept. No. ETL-0119, AD-A050 034), 33 pp.
(Army Engineer Topographic Laboratories, Fort Belvoir, Va.)

Abstract - A high speed parallel scanning scheme is described that uses high density linear sensor arrays to convert optical images into electrical signals for computer processing or storage. By using two 1,024-element linear arrays in a staggered line and x-y translational stages, a 9 x 9-inch transparency can be scanned and digitized into 8.5×10^7 pixels in 1 minute. Scan time can be reduced by increasing the slew rate of the stage or by increasing the scan line by using additional arrays. Since each array produces four simultaneous video signals, the system could be utilized as an input device for a parallel processor such as the STARAN. The video signals can be multiplexed onto a single line if desired.

ETL BIB

C-9

CHIU, H.-Y. and W. COLLINS, 1978, A Spectroradiometer for Airborne Remote Sensing, in Photogrammetric Engineering and Remote Sensing, v. 44, no. 4, Apr. 1978, pp. 507-517.
(NASA/Institute for Space Studies, New York, N.Y; Columbia Univ., New York, N.Y.)

Abstract - A parallel electro-optical input spectroradiometer system with 500 channels and operating in the 400-1100 nanometer wavelength region has been designed and fabricated for use in a light aircraft. The airborne system was conceived for determining the high-resolution properties of various ground targets of interest in remote sensing. Spectral radiance data at 4-digit resolution are generated on a 9-track tape in computer compatible format. At a survey altitude of 600 meters and 200 km/hr ground speed, a ground resolution element is 18 meters square. The data acquisition rate is 2.5 spectra per second of 500 channels each. Absolute radiometric calibration is achieved with a standard lamp that is calibrated against an NBS secondary standard source. The linearity of instrument response to intensity change is 1 percent. The rapid data acquisition in parallel input channels is essential for obtaining good quality spectral data at 2 nanometer or better wavelength resolution and high sensitivity under airborne operating conditions. These data have yielded spectral information valuable to basic remote sensing research in the areas of detecting geologic zones of alteration, monitoring the condition of vegetation canopies, and determining the spectral properties of water bodies.

Handsearch

CLARK, R.A., R.G. RADOSEVIC, and W.E. SCHMIDT, 1976, Associative Array Processing of Raster Scan Data for Automated Cartography, in Proceedings of the American Society of Photogrammetry and American Congress on Surveying and Mapping Fall Convention, Oct. 26-31, 1975, pp. 381-411.
(Army Engineer Topograpnic Labs., Fort Belvoir, Va.; Goodyear Aerospace Corp., Akron, Ohio; U.S. Geological Survey, Topographic Div., Reston, Va.)

Abstract - The paper describes some of the techniques, status and results for application of an associative array processor (AAP) to raster processing tasks in an automated cartographic system. Particular attention is devoted to AAP raster processing techniques for line symbol generations (single lines, double lines, and broken lines), area fill symbol generation, points symbol generation (school, church, etc.), line separation by thickness, and vectorization (line following). The discussion includes a summary of the AAP performance for the above tasks and some AAP cartographic system considerations. Processing times on the AAP are dramatically lower than those on a conventional computer that processes data sequentially. It is concluded that raster-scanned data can be successfully processed and that a raster scanner linked to an associative array processing device may replace current digitizing techniques.

NASA

C-11

COLVOCORESSES, A.P., 1979, Proposed Parameters for MAPSAT, in Photogrammetric Engineering and Remote Sensing, v. 45, no. 4, April 1979, pp. 501-506. (U.S. Geological Survey, Reston, Va.)

Abstract - LANDSATs-1, -2, and -3, although not defined as mapping satellites, are in fact effectively recording the Earth's surface in a form suitable for presentation as small-scale image maps. These spacecraft have demonstrated the effectiveness of Earth sensing, which should now move from the research to the operational phase. LANDSAT-D is designed to continue the research effort, but NASA, whose charter precludes operations, has not defined an operational system. An operational LANDSAT has previously been proposed in technical terms, but this concept was limited to the orthographic (two-dimensional) mode demonstrated by LANDSATs-1, -2, and -3. Mapping involves topography as well as planimetry, and a satellite compatible with the LANDSAT that also resolves the three-dimensional mode of topography is proposed. Such a satellite requires very high stability and pointing accuracy. The current state-of-the-art permits such a satellite to be built and flown in a mode suitable for automated modeling of the Earth's surface in three- as well as two-dimensional modes. The satellite would be complementary to or could be combined with the operational LANDSAT previously proposed and it is suggested that it be designated the Automated Mapping Satellite or MAPSAT.

Handsearch

CONTI, R. and G. VIRKLER, 1976, Analog to Digital Graphic Conversion. Final Report, Jun. 74-Dec. 75, (Contr. No. F30602-74-C-0348; Rept. No. AD-A026 137), 241pp. (PRC Information Sciences Co., Rome, N.Y.)

Abstract - A primary concern in the development of the Advanced Cartographic System is the application of the raster-scanning technology to the process of digital data collection. This report describes methods developed which determine the feasibility of linealizing raster scanned data with the aid of coarsely tracked lineal files and the practicability of developing an evaluation matrix directly from the raster format of a scanned color-coded contour manuscript. Software developed under this effort was intended mainly for demonstration purposes and further refinement will be required for an efficient production system.

DDC

C-13

COOK, J.J., 1976, Remote Sensing of Earth Resources: Fundamental Principles, Data Collection Sensors and Information Extraction Techniques, in International Earth Resources Management Symposium, Houston, Tex. Jan. 27-29, 1976, pp. 141-197.

Abstract - Fundamental principles of force fields and radiation (particularly electromagnetic radiation) are presented and discussed in relation to the energy processes involved in remote sensing. Sources of electromagnetic radiation are discussed along with a treatment of atmospheric effects on remote sensing signals. Particular emphasis is placed on the multispectral scanner as a unique and powerful data collection device. Automatic processing functions, techniques, methods, and equipment are discussed with emphasis on pre-processing for feature enhancement and reduction of variance. A special purpose multispectral parallel-channel processor system is presented.

GEO-G

COOPER, M.T., 1979, Terrain Characteristics from Remote Sensors, (Rept. No. DN 888042). (Naval Coastal Systems Center, Panama City, Fla.)

Abstract - The objective of this work is to develop a digital capability to exploit remotely sensed, active and passive multispectral data in the ultraviolet, visible, and infrared optical bands to provide information on basic terrain factors or descriptors, such as drainage, vegetation, soils, geology, and hydrology in areas of interest. By providing high spatial and high frequency resolution data in a form which readily lends itself to digital signal processing, remote sensors possess a unique capability to acquire and present information describing the character of the area under scan. The approach of this task will be to examine the state of the art and the potential of various reconnaissance means to provide terrain description information. Concurrently, analysis techniques will be developed for registering and overlaying features and control points observed in imagery from electro-optic and photographic products.

DDC-WU

C-15

CRANE, R.B., 1974, Adaptive Processing of MSS Data Using a Decision-Directed Kalman Filter, in Proceedings of the 9th International Symposium on Remote Sensing of the Environment, Ann Arbor, Mich., Apr. 15-19, 1974, v. 2, pp. 781-791.
(Environmental Research Inst., Ann Arbor, Mich.)

Author Abstract - A decision-directed Kalman filter is shown to be applicable to adaptive processing of multispectral data. Improved recognition accuracy results from the use of the Kalman filter, and the improvement is relatively insensitive to filter parameters, e.g., updating rate. Approximagely ten percent additional computer time is required.

NASA

CRAWFORD, W.L. and R.R. GUESS, 1974, Numerical Ground Image System -- Computer Programs, Data Storage, and Data Systems Used in Terrain Analysis for Highway Construction, (Rept. No. PB-249512/5; THD-1-19-71-186-2F), 152pp.
(Texas Highway Dept., Austin, Tex.; Federal Highway Administration, Div. of Automation, Washington, D.C.)

Abstract - This report (1) explains computer methods for representing a terrain surface using a numerical surface and (2) provides user instructions for data retrieval of cross-sections computed from this surface model. The appendix contains an example problem, a detailed explanation of the algorithms used, and the program documentation for the numerical ground image system.

NASA/NTIS

C-17

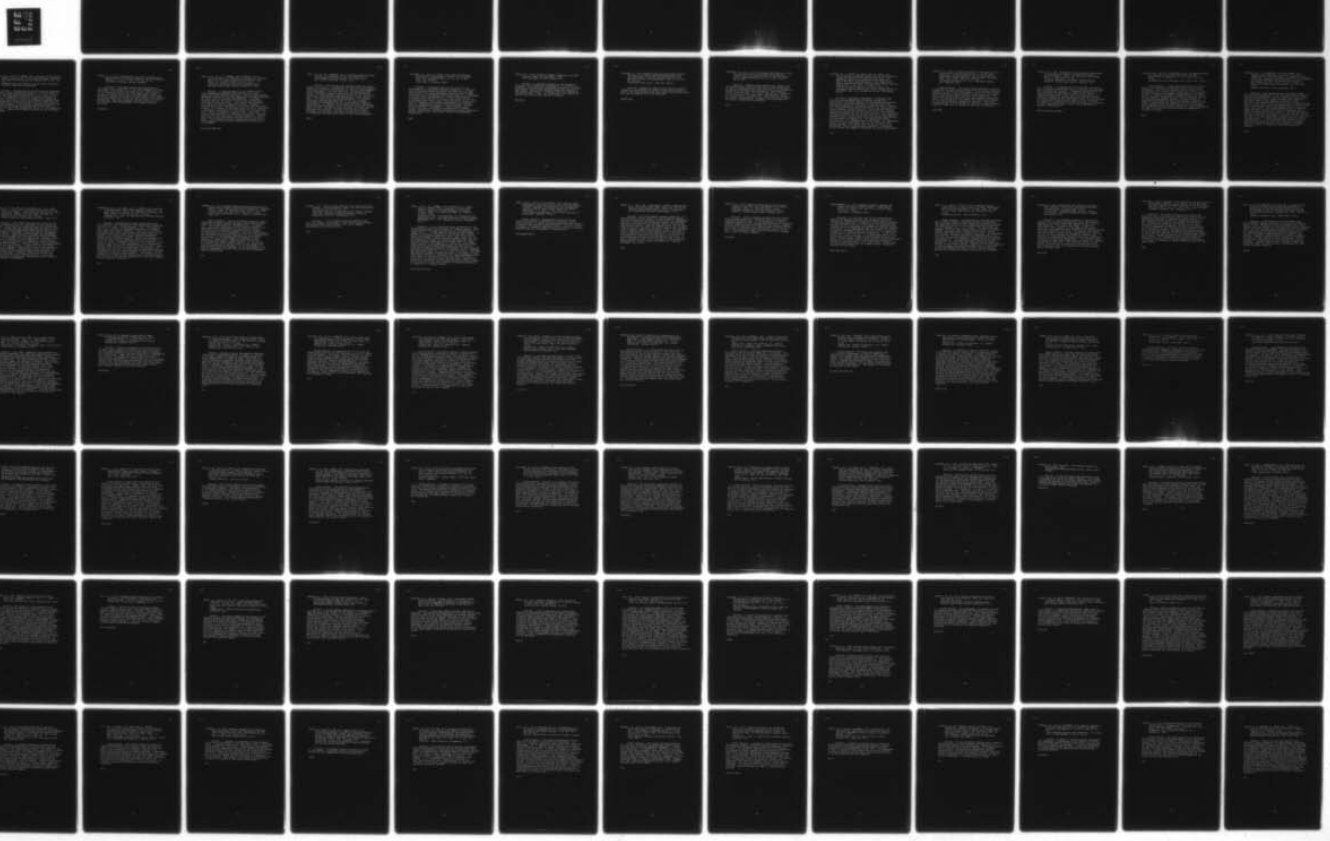
CURRIER, P., 1972, Terrain Factor Analysis and Automatic Color Coded Mapping Utilizing the IDECS (Image Discrimination, Enhancement, Combination and Sampling), Final Technical Report, Aug 72, (Contr. No. DAAK02-71-C-0474; Rept. No. CRES-TR-208-1; AD-755 531), 70 pp. (Kansas Univ. Center for Research, Inc., Lawrence Remote Sensing Lab., Lawrence, Kans.)

Author Abstract - The report describes a technique for automatic generation of color-coded maps which define the amount of time required to construct a military airfield. The input data is a set of terrain factors in overlay form and the technique relies upon the use of the IDECS System (Image Discrimination, Enhancement, Combination and Sampling) of the Center for Research, Inc., University of Kansas. The color-coded map is generated by a PDP-15/20 computer which reads the terrain factors which have been previously stored on the IDECS disc, and applies them to a model in memory which calculates the amount of time for the airfield construction on a point by point basis. The computer then sorts the output into preselected time intervals and writes them on a digital disc. The appropriate disc channels are then displayed via the IDECS on a color television monitor for viewing as a composite color map.

DDC

AD-A076 148 LOGICAL TECHNICAL SERVICES CORP VIENNA VA F/G 14/5
AUTOMATIC FEATURE EXTRACTION: AN ANNOTATED BIBLIOGRAPHY.(U)
MAY 79 DAAK70-78-C-0195
UNCLASSIFIED ETL-0189 NL

2 OF 5
AD
A076148



DALTON, C.C., 1974, Automatic Classification and Mapping of Earth Resources Satellite Data, (Rept. No. NASA-TM-X-64801), 33 pp.
(National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.)

Author Abstract - This report examines the spatial and spectral clustering technique for the unsupervised automatic classification and mapping of Earth Resources Satellite data, and makes theoretical analysis of the decision rules and tests in order to suggest how the method might best be applied to other flight data such as Skylab and Spacelab.

NASA/NTIS

D-2

DALTON, J.T., 1975, Configuration Description and Load Analysis for the Atmospheric and Oceanographic Information Processing System (AOIPS), (Rept. No. NASA-TM-X-70960, X-933-75-217), 41 pp. (National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.)

Abstract - A computer system for processing image data is described. It essentially consists of two minicomputer systems. System components are listed and discussed, and flow charts are shown.

NASA/NTIS

DANIS, N.J. and A.J. GRUBIS, 1977, Coherent Radar I.D. Study. Volume II. APR Software Documentation. Final Technical Report, 24 May, 1976 - 24 May, 1977, (Contr. No. F30602-76-C-0305; Rept. No. AVSD-0216-77-CR-VOL-2, RADC-TR-77-350-VOL-2, AD-B023 640L), 122 pp.
(AVCO Systems Div., Wilmington, Mass.)

Abstract - This report documents the APR software developed for four specific satellite classification problems. The software includes preprocessing, feature extraction and classification.

DDC

D-4

DAS, Y., and W.M. BOERNER, 1978, On Radar Target Shape Estimation Using Algorithms for Reconstruction from Projections, in IEEE Transactions on Antennas and Propagation, v. AP-26, Mar. 1978, (Rept. No. NRC A-7240, NRC T-0409), pp. 274-279.
(Manitoba University, Winnipeg, Canada)

Author Abstract - In radar identification of perfectly conducting targets, a need arises to determine a convex body from its cross-sectional areas normal to the lines of sight for a number of view angles. An approach based on the theory of the radon transform is used here to show that this problem is equivalent to the problem of image reconstruction from projections, which has been solved in many diverse disciplines. Two of the inversion algorithms developed in these fields are used to estimate object shapes from their cross-sectional areas, obtainable from the objects' far-field, backscattered ramp responses.

NASA

DAUS, S.J. and M.J. COSENTINO, 1977, The Use of Analysis of Variance Procedures for Defining Ground Conditions of Categories Generated in an Automatic Analysis of LANDSAT MSS Digital Data, in Proceedings of the 4th Annual Symposium on Machine Processing of Remotely Sensed Data, Purdue Univ., June, 1977, pp. 298-306. (Purdue Univ. Lab. for Applications of Remote Sensing, West Lafayette, Ind.)

Author Abstract - The results of this study have shown that analysis of variance procedures (ANOVA) can be used to relate ground or photo plot data to spectrally based computer classes in order to define the ground conditions of classes. However, careful structuring of the procedures, including training, allocation of samples, classification and locational transformations, is necessary to maintain the validity of the statistical test.

GEO-G

D-6

DAVID, D.J., J. DERIES, and F. VERGER, 1975, Automatic Cartography of ERTS Remote-Sensing Data, in Journal of the British Interplanetary Society (GB), v. 28, no. 9-10, Sept.-Oct. 1975, pp. 624-628. (ENSJF-1, Montrouge, France)

Abstract - The amount of available remote-sensing data, especially from satellites, is considerable and treatment of such numerous data needs the use of electronic data processing techniques. This paper describes an application of these techniques to the automatic cartography of ERTS data and reviews the advantages of the process.

NASA/EIX

DAVIS, B.J. and P.H. SWAIN, 1974, An Automated and Repeatable Data Analysis Procedure for Remote Sensing Applications, in Proceedings of the 9th International Symposium on Remote Sensing of the Environment, Ann Arbor, Mich., Apr. 15-19, 1974, v. 2, (Rept. No. NGL-15-005-112), pp. 771-774.
(Purdue Univ., West Lafayette, Ind.)

Author Abstract - A new multispectral data analysis procedure, based on LARSYS, has been developed which substantially reduces the influence of the analyst. The analysis is automated, including the interpretation of clustering results. The classification results obtained are repeatable and not biased by analyst subjectivity during the analysis.

NASA

D-8

DAVIS, W.A. and F.G. PEET, 1977, A Method of Smoothing Digital Thematic Maps, in Remote Sensing of the Environment, v. 6, no. 1, 1977, (Rept. No. NRC A-7634), pp. 45-49.
(Environment Canada, Forest Management Institute, Ottawa, Canada)

Abstract - The paper discusses the smoothing and gross feature extraction process as accomplished by minimal area recognition and reclassification of digital thematic maps derived from LANDSAT data. A method is proposed which involves scanning a classified picture and identifying all the connected regions in the picture. It is shown how one can choose minimal areas for the different classes on a digital thematic map, apply the described algorithm, and obtain a picture in which every region has an area greater than or equal to the chosen minimum. Illustrative pictures are included.

NASA/EIX/GEO-G

DAVIS, W.A. and F.G. PEET, 1977, Recognition and Modification of Areas Less than a Minimum--For Digital Thematic Map Processing, in Proceedings of the 4th Canadian Symposium on Remote Sensing, Quebec, Canada, May 16-18, 1977, (Rept. No. NRC A-7634), pp. 549-557. (Alberta Univ., Edmonton, Canada; Canadian Forestry Service, Forest Management Institute, Ottawa, Canada)

Abstract - With reference to related studies, the article discusses the processing of digital thematic maps from classified LANDSAT imagery such that after processing, the map regions have areas less than a preset minimum. The technique is based on an algorithm developed by Davis and Peet (1976) which finds all regions having areas less than a determined minimum and converts them to their most likely neighbor.

NASA

D-10

DECELL, H.P., JR. and L.F. GUSEMAN, JR., 1978, Linear Feature Selection with Applications, in Pattern Recognition, v. 11, no. 1, 1979, pp. 55-63. (Univ. of Houston, Houston, Tex.; Texas A&M Univ., College Station, Tex.)

Abstract - This paper selectively surveys contributions in linear feature selection which have been developed for the analysis of multipass LANDSAT data in conjunction with the Large Area Crop Inventory Experiment. Most of the results surveyed have been obtained since early 1973 and have applications outside of satellite remote sensing. A few of the theoretical results and associated computational techniques have appeared either in journal articles or in proceedings of technical symposia. However, most of these contributions appear only in scattered contract reports and are not generally known by the scientific community.

Handsearch

DEFIGUEIREDO, R.J., 1978, Optimization Techniques for Feature Extraction in Automatic Pattern Recognition (Contr. No. DF040070; AFOSR-2777-75; Rept. No. GQF 40070 3)
(Rice Univ., Graduate School of Electrical Engineering, Houston, Tex.)

Abstract - Increasing automation of Air Force reconnaissance, intelligence, command and control functions requires increased capability to manipulate and reduce large amounts of data. More powerful data reduction (pattern recognition) algorithms will be provided to increase current capabilities to analyze available data. This research will develop a general framework and techniques for the construction of a feature extraction map from a space of high dimension to a space of low dimension, the map being optimal in the sense that it will reduce the dimensionality of the data with the least degradation in its structure. In this approach, the structure of the data in the space will be learned through clustering procedures, which in turn will reveal the functional or functionals that must be minimized in the dimensionality-reduction stage to keep the degradation in the structure of the transformed data to a minimum.

SSIE

DINSTEIN, I.H., 1972, Texture Tone Study (Quantizing on the IDECS/PDP). Interim Technical Report No. 3, 1 Nov. 71-71-1 Mar 72, (Contr. No. DAAK02-70-C-0388; Rept No. CRINC-TR-182-3-ITR3, AD-743 526, ETL-CR-72-3); 33pp. (Kansas Univ. Center for Research Inc., Remote Sensing Lab, Lawrence, Kans.) Kans.)

Author Abstract - The hardware design and an algorithm for equal probability quantizing on the IDECS/PDP are reported. The PDP 15/20 computer is interfaced to the IDECS (Image Discrimination Enhancement and Combination System) which is an analog-digital near real time image processing system. A brief description of the IDECS is provided. The addition of the designed hardware will make it possible to input film images to the IDECS/PDP and perform both quantizing and processing.

NTIS/DDC

DINSTEIN, I.H., R.M. HARALICK, K.S. SHANMUGAM, and D. GOEL, 1972, Texture Tone Study. Classification Experiments. Interim Technical Report No. 4, (Contr. No. DAAK02-70-C-0388; Rept. No. CRES-TR-182-4, AD 759 505, ETL-CR-72-16), 207 pp.
(Kansas Univ., Center for Research , Inc., Remote Sensing Lab, Lawrence, Kans.)

Author Abstract - Four aerial photographic image data sets were classified on the basis of a large class of quickly computable textural features. When the most appropriate features and decision rule were selected, identification accuracy on the order of 75 percent was obtained for 9 to 11 terrain categories. Conclusions drawn from these experiments suggest: that the most powerful features are the entropy and inverse difference features measured at distance 1 and at distance 1/10th the length of the image side; that the class of quickly computable textural features needs to be supplemented by tonal and context features in order for better identification to be obtained. This second conclusion is not to be unexpected since a photointerpreter who tries to make interpretations on the basis of a 1/8 inch x 1/8 inch square specially processed for high contrast on a 9 inch x 9 inch 1:20,000 aerial photograph does not do any better than 75 percent correct identification as previously reported.

NTIS/DDC

D-14

DONKER, N.H.W. and N.J. MULDER, 1977, Analysis of MSS Digital Imagery with the Aid of Principal Component Transform - For Image Processing, in ITC Journal, 1977-3, pp. 434-466.
(International Institute for Aerial Survey and Earth Sciences, Enschede, Netherlands)

Abstract - The application of the principal component transform, a data compression technique, to the analysis of LANDSAT multispectral scanning bands 4, 5, 6 and 7 is discussed. The application involves a selective sampling of spectrally significant classes in automatically equalized histograms, followed by use of the principal component transform to produce a large proportion of the variance found in the LANDSAT imagery. The principal component transform technique has the advantage of reducing the feature space to be analyzed from a four-dimensional entity to a two-dimensional entity. Sample color imagery produced by the technique is examined.

NASA

DOWMAN, I.J., 1977, Developments in On Line Techniques for Photogrammetry and Digital Mapping, in Photogrammetric Record, v. 9, No. 49, Apr. 1977, pp. 41-54. (University College, London, England)

Abstract - This paper reviews the development of instruments and systems for on line photogrammetry and examines some of the systems which are in use. Applications of the analytical plotter are described; these include its use for the derivation of data from photography taken with non-metric cameras, plotting in a plane which is not parallel to the instrument axis system and the plotting of two media photography. Some new equipment and new techniques for editing data from photogrammetric instruments are also described.

Handsearch

D-16

DOWNS, S.W., JR., G.C. SHARMA, and C. BAGWELL, 1977, A Procedure Used for a Ground Truth Study of a Land Use Map of North Alabama Generated from LANDSAT Data, (Rept. No. NASA-TN-D-8420, M-209), 62 pp. (National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.)

Abstract - A land use map of a five county area in North Alabama was generated from LANDSAT data using a supervised classification algorithm. There was good overall agreement between the land use designated and known conditions, but there were also obvious discrepancies. In ground checking the map, two types of errors were encountered - shift and misclassification - and a method was developed to eliminate or greatly reduce the errors. Randomly selected study areas containing 2,525 pixels were analyzed. Overall, 76.3 percent of the pixels were correctly classified. A contingency coefficient of correlation was calculated to be 0.7 which is significant at the alpha = 0.01 level. The land use maps generated by computers from LANDSAT data are useful for overall land use by regional agencies. However, care must be used when making detailed analysis of small areas. The procedure used for conducting the ground truth study together with data from representative study areas is presented.

NTIS/NASA/ERTS-BIB

DUNN, L.M. and A.E. PRESSMAN, 1973, Integrated Remote Sensing System, in Proceedings of the 2nd Conference on Environmental Quality Sensors, Las Vegas, Nev., Oct. 10-11, 1973, Sec. I, pp. 1-31.

Abstract - The National Environmental Research Center (NERC) in Las Vegas is responsible for developing environmental monitoring techniques and programs for the U.S. Environmental Protection Agency. To carry this out, the Monitoring Operations Laboratory, Imagery Acquisition and Interpretation Branch, is developing an integrated system for the collection, processing, interpretation and reporting of remote sensing data. Five major areas are being addressed: (1) outfall detection, location and analysis; (2) oil spill damage assessment and documentation; (3) an agricultural chemical runoff model; (4) nonpoint source water pollution monitoring approaches and techniques; (5) a technical assistance program. Under the last, the goal of NERC-Las Vegas is to provide annotated data displays, raw data with location indexes, isothermal contour maps, and final interpretation reports for immediate regional needs within 45 days of notification.

GEO-G

E-1

EBERSOLE, J.F., and J.C. WYANT, 1976, Real-Time Optical Subtraction of Photographic Imagery for Difference Detection, in Applied Optics, v. 15, no. 4, Apr. 1976, pp. 871-876.
(Itek Corp., Lexington, Mass.)

Abstract - The primary goal of this work was the development of a difference detection capability. Interferometric techniques described permit real-time optical image subtraction of two input photograph transparencies without the necessity of intermediate processing steps (e.g., holograms or contact-print transparencies). These interferometric techniques allow the use of a white-light source as well as an extended light source, small input-collimator optics, and optical components with minimal requirements on wavefront quality. Experimental results with NASA LANDSAT (formerly ERTS) photographs are presented. There are many applications for such a technology, including earth resource studies, meteorology, automatic surveillance and/or inspection, pattern recognition, urban growth studies, and bandwidth compression.

COMP

EDSON, D.T., 1972, Automatic Thematic Mapping in the EROS Program, (Rept. No. GU710336), 13 pp. (U.S. Geological Survey, Reston, Va.)

Abstract - A specified approach to the automatic extraction and cartographic presentation of thematic data contained in multispectral photographic images is presented. Experimental efforts were directed toward the mapping of open waters, snow and ice, infrared reflective vegetation, and massed works of man. The system must also be able to process data from a wide variety of sources.

NASA/NTIS

E-3

ELLEFSEN, R., 1974, Automatic Digital Processing of ERTS-1 MSS Data in an Urban Land-Use Mapping Experiment, in Proceedings of the 40th Annual Meeting of the American Society of Photogrammetry, Mar. 10-15, 1974, pp. 405-416.
(California State Univ., San Jose, Calif.)

Abstract - Mapping by computer from satellite data is compared to conventional air photo interpretation mapping. Results for three metropolitan areas (San Francisco Bay, Phoenix, and Washington, D.C.) are presented.

GEOREF/NASA

ELLEFSEN, R.A., et al, 1977, Computer-Aided Mapping of Land Use and Land Cover Using LANDSAT Multispectral Scanner Data, in Remote Sensing of the Electromagnetic Spectrum (R.S.E.M.S.), v. 4, no. 4, 1977, pp. 84-102.

Abstract - Computer aided mapping from LANDSAT data in digital format can provide not only timely acquisition of land use information but also the basis of an information system for processing such information. Multitemporal LANDSAT data are used. The classification map is produced on a line printer with each symbol representing a pixel, or the data can be converted to a colour film internegative for direct interpretation. Examples from Washington and the Pacific Northwest are presented.

GEO-G

E-5

ELLEFSEN, R., L. GAYDOS, P. SWAIN, and J.R. WRAY, 1974, New Techniques in Mapping Urban Land Use and Monitoring Change for Selected U.S. Metropolitan Areas - An Experiment Employing Computer-Assisted Analysis of ERTS-1 MSS Data, in Proceedings of the Symposium on Remote Sensing and Photo Interpretation, Banff, Alberta, Canada, Oct. 7-11, 1974, v. 1, pp. 51-63. (San Jose State University, San Jose, Calif; U.S. Geological Survey, Menlo Park, Calif; Purdue University, Lafayette, Ind.; U.S. Geological Survey, Washington, D.C.)

Abstract - Successful experiments in mapping urban land use, through employment of pattern recognition algorithms in a digital computer by processing multispectral scanner data from Earth Resources Technology Satellite-1 have been conducted by researchers of the Geography Program, U.S. Geological Survey, and the Laboratory for Applications of Remote Sensing, Purdue University. Map forms are computer line-printer output and colored prints from a film recorder. Numerous categories of land use and land cover were identified and mapped to make full use of the potential of the computer/scanner system. Several innovations in machine-aided analysis were developed in response to: (1) making rural/urban distinctions; (2) arranging data in map format; (3) aggregating results by statistical units; and (4) solving other peripheral problems. Recitation and critique of the evolved methodology reveals progress made, identifies limitations of the system, and suggests directions for future improvement.

NASA

EPPLER, W.G., 1974, An Improved Version of the Table Look-Up Algorithm for Pattern Recognition -- for MSS Data Processing, in Proceedings of the 9th International Symposium on Remote Sensing of Environment, Ann Arbor, Mich., Apr. 15-19, 1974, pp. 793-812. (Lockheed Electronics Co., Inc., Aerospace Systems Div., Houston, Tex.)

Author Abstract - The table look-up approach to pattern recognition has been used for three years at several research centers in a variety of applications. A new version has been developed which is faster, requires significantly less core memory, and retains full precision of the input data. The new version can be used on low-cost minicomputers having 32K words (16 bits each) of core memory and fixed-point arithmetic; no special-purpose hardware is required. An initial Fortran version of this system can classify an ERTS computer-compatible tape into 24 classes in less than 15 minutes.

NASA/COMP

F-1

FALLER, K.H., 1976, Procedure for Detection and Measurement of Interfaces in Remotely Acquired Data Using a Digital Computer, (Rept. No. NASA-TM-X-74636, NASA-TR-R-472, JSC-5-467), 46 pp.
(National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, Tex.)

Abstract - A technique for the detection and measurement of surface feature interfaces in remotely acquired data was developed and evaluated. A computer implementation of this technique was effected to automatically process classified data derived from various sources such as the LANDSAT multispectral scanner and other scanning sensors. The basic elements of the operational theory of the technique are described, followed by the details of the procedure. An example of an application of the technique to the analysis of tidal shoreline length is given with a breakdown of manpower requirements.

NTIS/NASA/ERTS BIB/GEO-G

FISCHLER, M.A., and R.A. ELSCHLAGER, 1973, The Representation and Matching of Pictorial Structures, in IEEE Transactions on Computers, v. C-22, Jan. 1973, pp. 67-92.
(Lockheed Missiles and Space, Inc., Palo Alto, Calif.)

Author Abstract - Given some description of a visual object, the problem is to find that object in an actual photograph. Part of the solution to this problem is the specification of a descriptive scheme, and a metric on which to base the decision of goodness of matching or detection. We offer a combined descriptive scheme and decision metric which is general, intuitively satisfying, and which has led to promising experimental results. We also present an algorithm which takes the above descriptions, together with a matrix representing the intensities of the actual photograph, and then finds the described object in the matrix. The algorithm uses a procedure similar to dynamic programming in order to cut down on the vast amount of computation otherwise necessary.

NASA

F-3

FLEMING, M.D., J.S. BERKEBILE, and R.M. HOFFER, 1975, Computer-Aided Analysis of LANDSAT-1 MSS Data - A Comparison of Three Approaches, Including a 'Modified Clustering' Approach, in Proceedings of the 2nd Symposium on Machine Processing of Remotely Sensed Data, West Lafayette, Ind., Jun. 3-5, 1975, (Contr. No. NAS9-14016, NAS5-21880, NAS9-13380), pp. 1B-54 to 1B-61.
(Purdue University, West Lafayette, Ind.)

Abstract - Three approaches for analyzing LANDSAT-1 data from Ludwig Mountain in the San Juan Mountain range in Colorado are considered. In the 'supervised' approach the analyst selects areas of known spectral cover types and specifies these to the computer as training fields. Statistics are obtained for each cover type category and the data are classified. Such classifications are called 'supervised' because the analyst has defined specific areas of known cover types. The second approach uses a clustering algorithm which divides the entire training area into a number of spectrally distinct classes. Because the analyst need not define particular portions of the data for use but has only to specify the number of spectral classes into which the data is to be divided, this classification is called 'nonsupervised'. A hybrid method which selects training areas of known cover type but then uses the clustering algorithm to refine the data into a number of unimodal spectral classes is called the 'modified-supervised' approach.

NASA

FORSEN, G.E., J.C. LIETZ, D.R. HOUSE, G.T. STEVENS, and M.J. GILLOTTE, JR., 1975, Advanced Multispectral Image Descriptor System (AMIDS). Final Technical Report, Jul. 1973-Jun. 1974, (Contr. No. F30602-73-C-0371; Rept. No. PAR-74-17, AD-007 007/8ST), 78 pp. (Pattern Analysis and Recognition Corp., Rome, N.Y.; Rome Air Development Center, Griffiss AFB, N.Y.)

Abstract - Studies by military and civil agencies indicate that targets of military significance may be automatically classified by digital processing of multi-spectral airborne reconnaissance imagery. The objective of this effort is the development and implementation of expanded preprocessing and analysis techniques which will use multichannel data to classify image points. The project resulted in the addition to the dedicated digital image processing system at RADC of special file handling programs and a comprehensive sub-set of OLPARS (On-Line Pattern Analysis and Recognition System). These routines allow a complete thematic mapping (point recognition) application to be performed in an interactive, efficient manner.

NTIS

F-5

FORSEN, G.E., F.H. FENG, M.J. GILLOTTE, JR., J.C. LIETZ, and D.J. LUCEY, 1977, Advanced Digital Exploitation Techniques (ADET). Final Technical Report, Apr. 1977, (Contr. No. F30602-75-C-0141; Rept. No. PAR-77-3, RADC-TR-77-145, AD-A040 769), 253 pp. (Pattern Analysis and Recognition Corp., Rome, N.Y.)

Abstract - This effort developed and tested certain digital techniques that are applicable to the problem of tactical target detection using multispectral aerial photography. In addition, key algorithms were provided for the Digital Interactive Complex for Image Feature Extraction and Recognition (DICIFER) located at Rome Air Development Center (RADC). Algorithms were designed and implemented to provide the capability for normalizing digitized image data. These include the following areas: radiometric and geometric corrections for the Computer Eye Digitization device, point-spread function correction, and registration program embellishments. A general purpose image-combinations program was also provided. A major task of this effort was the development of sensor/sun position and atmospheric correction programs. Experimental efforts included the digitization of multispectral imagery and generation of ground truth data. Automatic classification logic was designed and tested on a limited data set. This logic was successful in separating camouflaged tactical targets from vegetative backgrounds.

DDC

FREDERKING, R.L., T.R. WEST, and C.J. STOHR, 1974, Analysis of Multispectral Data Using Computer Techniques - Virginia Test Site, (Contr. No. DOT-FH-11-7565; Rept. No. LARS-196200-1-T-VTS, PB-267 822), 199 pp. (Purdue Univ., Lab. for Applications of Remote Sensing, Lafayette, Ind.)

Abstract - Multispectral remote sensing data were collected over the Virginia test site during the spring and fall of 1970, April 7-8 and December 14-15. The Virginia test site is located in northwestern Virginia in Augusta County near the town of Staunton. Twelve miles in length, the flight line trends northwestward at right angles to the prominent structural trends of the Appalachian Mountain system. Soils consist of residual material formed by weathering of the parent bedrock. Local relief ranges from 100 to 600 feet and the elevation from 250 to 1950 feet above sea level. Presumably because of the relatively steep slopes in the area, a large percentage of the surface was covered either by forest or pasture growth with only a minor fraction used for row-crop production. Geologically, the Virginia site consists of folded Cambrian and Ordovician Age sedimentary rocks with minor amounts of quarternary alluvium accumulated along the stream channels. The purpose of the research was to analyze multispectral data from the Virginia test site using the current capabilities of the LARS computer-assisted analyses techniques.

NTIS

FREEMAN, H., 1977, Automatic Data Processing Techniques for Graphic-Data Display, Generation and Analysis. Interim Report, 1 Sept. 1976-31 Aug. 1977, (Contr. No. AFOSR-76-2937; Rept. No. CRL-54, AD-A049 317), 24 pp. (Rensselaer Polytechnic Inst., Computer Research Lab, Troy, N.Y.)

Author Abstract - This is an Interim Technical Report describing research carried out under Grant AFOSR-76-2937 during the 12-month period 1 September 1976 - 31 August 1977. The overall objective of the research program is to make significant improvements in the state-of-the-art relating to the extraction, representation and computer interpretation of line drawing data. Specific tasks during the reporting year were concerned with (1) the reconstruction of solid-object descriptions from multiple photographic projections, (2) the development of programs for the removal of 'hidden lines' from the projection of both planar-faced and quadric-surface objects, (3) the design of a generalized chain coding scheme for the compact and precise description of map data, (4) the development of a line-drawing processing language, (5) an investigation into some new approaches to scale- and orientation-independent shape classification.

DDC

GALLOWAY, M.M., 1974, Texture Analysis Using Gray Level Run Lengths. Technical Report, (Rept. No. NSF-OCA-GJ32258X-32, TR-314, PB-237 468), 57 pp.
(Maryland University, Computer Science Center, College Park, Md.; National Science Foundation, Office of Computing Activities, Washington, D.C.)

Abstract - A set of texture features based on gray level run lengths is described. Good classification results are obtained with these features on a set of samples representing nine terrain types.

NTIS

GOETZ, A.F.H., M.J. ABRAMS, A.R. GILLESPIE, B.S. SIEGAL, and D.P. ELSTON, 1976, Comparison of Skylab and LANDSAT Images for Geologic Mapping in Northern Arizona, (Contr. No. NAS7-100; Rept. No. NASA-CR-147503), 201pp.
(California Inst. of Technology, Jet Propulsion Lab., Pasadena, Calif.; NASA Earth Resources Survey Program, Washington, D.C.; U.S. Geological Survey, Flagstaff, Ariz.)

Abstract - It was found that based on resolution, the Skylab S190A products were superior to LANDSAT images. Based on measurements of shoreline features in Lake Mead S190A images had 1.5 - 3 times greater resolution than LANDSAT. In general, the higher resolution of the Skylab data yielded better discrimination among rock units, but in the case of structural features, lower sun angle LANDSAT images (50 deg) were superior to higher sun angle Skylab images (77 deg). The most valuable advantage of the Skylab over the LANDSAT image products is the capability of producing stereo images. Field spectral reflectance measurements on the Coconino Plateau were made in an effort to determine the best spectral bands for discrimination of the six geologic units in question, and these bands were 1.3, 1.2, 1.0, and 0.5 microns. The EREP multispectral scanner yielded data with a low signal to noise ratio which limited its usefulness for image enhancement work. Sites that were studied in Arizona were Shivwits Plateau, Verde Valley, Coconino Plateau, and Red Lake. Thematic maps produced by the three classification algorithms analyzed were not as accurate as the maps produced by photointerpretation of composites of enhanced images.

NTIS/NASA/ERTS-BIB

GOETZ, A.F.H., and F.C. BILLINGSLEY, 1974, Digital Image Enhancement Techniques Used in Some ERTS Application Problems--Geology, Geomorphology, and Oceanography, in NASA, Goddard Space Flight Center, 3rd ERTS-1 Symposium, v. 1., Sect. 8, pp. 1971-1992. (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif.)

Author Abstract - Enhancements discussed include contrast stretching, multiratio color displays, Fourier plane operations to remove striping and boosting MTF response to enhance high spatial frequency content. The use of each technique in a specific application in the fields of geology, geomorphology and oceanography is demonstrated.

NASA/GEOREF/GEO-G

G-4

GORNY, A.J., 1977, CAM - Cartographic Automatic Mapping Program, 5th Edition, Mag. Tape, (Rept. No. PB-270 303). (Central Intelligence Agency, Office of Geographic and Cartographic Research, Washington, D.C.)

Abstract - CAM (Cartographic Automatic Mapping) is an IBM System/360 Fortran level H or G and assembly language code ALC program that performs a wide variety of cartographic functions. Included are 16 map projections, the universal transverse Mercator UTM grid system, and an XY one for one data display routine. CAM will connect points with straight lines or circles, and draw line grids, range rings, ellipses, cones, symbols, azimuths and elevation rings. Included is a world coastline file of 8200 points, but CAM may also be used in conjunction with World Data Bank I, a 10,000 point file separately contained on accession no. PB-223 178. A significant new feature of CAM-5th edition also allows its use in conjunction with World Data Bank II, which contains approximately 7 million points contained on 5 separate geographic area files.

NTIS

GRAHAM, M.H., 1977, Digital Overlaying of the Universal Transverse Mercator Grid with LANDSAT Data Derived Products, (Rept. No. NASA-TM-58200), 45 pp. (National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.)

Abstract - Picture elements of data from the LANDSAT multispectral scanner are correlated with the universal transverse Mercator grid. In the procedure, a series of computer modules was used to make approximations of universal transverse Mercator grid locations for all picture elements from the grid locations of a limited number of known control points and to provide display and digital storage of the data. The software has been written in Fortran 4 language for a Varian 70-series computer.

NTIS/NASA

GRAMENOPOULOS, N., 1975, Automated Thematic Mapping and Change Detection of ERTS-A Images. Final Report, (Contr. No. NAS5-21766; Rept. No. E75-10194, NASA-CR-142343), 78 pp.
(Itek Corp., Lexington, Mass.)

Abstract - In the first part of the investigation, spatial and spectral features were developed which were employed to automatically recognize terrain features through a clustering algorithm. In this part of the investigation, the size of the cell, which is the number of digital picture elements used for computing the spatial and spectral features, was varied. It was determined that the accuracy of terrain recognition decreases slowly as the cell size is reduced and coincides with increased cluster diffuseness. It was also proven that a cell size of 17 x 17 pixels when used with the clustering algorithm results in high recognition rates for major terrain classes. ERTS-1 data from five diverse geographic regions of the United States were processed through the clustering algorithm with 17 x 17 pixel cells. Simple land use maps were produced and the average terrain recognition accuracy was 82 percent.

NASA/NTIS/GEO-G

GUPTA, J.N., and P.A. WINTZ, 1975, A Boundary Finding Algorithm and Its Applications, in IEEE Transactions on Circuits and Systems, v. CAS-22, (Rept. No. MDA-903-74-C-0098, NGL-15-005-112, NGR-15-005-152), 12 pp.
(Purdue University, West Lafayette, Ind.)

Author Abstract - An algorithm for locating gray level and/or texture edges in digitized pictures is presented. The algorithm is based on the concept of hypothesis testing. The digitized picture is first subdivided into subsets of picture elements, e.g., 2 x 2 arrays. The algorithm then compares the first- and second-order statistics of adjacent subsets; adjacent subsets having similar first- and/or second-order statistics are merged into blobs. By continuing this process, the entire picture is segmented into blobs such that the picture elements within each blob have similar characteristics. The boundaries between the blobs comprise the boundaries. The algorithm always generates closed boundaries. The algorithm was developed for multispectral imagery of the earth's surface. Application of this algorithm to various image processing techniques such as efficient coding, information extraction (terrain classification), and pattern recognition (feature selection) are included.

NASA

H-1

HAEFNER, H., 1975, Snow Survey and Vegetation Growth in High Mountains (Swiss Alps) and Additional ERTS Investigations in Switzerland, 45 pp. (Zurich Univ., Geographisches Institut, Zurich, Switzerland; NASA Earth Resources Survey Program, Washington, D.C.)

Abstract - Two different methods, an analog and a digital one, have been developed for rapid and accurate mapping of the areal extent and changes in snow cover in high mountains. The quick-look method is based on individual visual control of each image using a photo quantizer which provides exact references for density slicing with high resolution lith-film. The digital snow classification system is based on discriminant analysis with the data of the four multispectral bands as variables and contains all preprocessing, feature extraction, and mapping steps for an operational application. Two different sets of sampling groups were established which apply to different conditions of snow cover. The first one serves for the normal situation with a uniform dry and new snow cover. The second one serves for situations with partly thawing and/or refrozen snow.

NASA/NTIS

HALAJIAN, J. and H. HALLOCK, 1972, Principles and Techniques of Polarimetric Mapping, in Proceedings of the 8th International Symposium on Remote Sensing of the Environment, Ann Arbor, Mich., Oct. 2-6, 1972, vol. 1, pp. 523-540. (Grumman Aerospace Corp., Bethpage, N.Y.)

Abstract - This paper introduces the concept and potential value of polarimetric maps and the techniques for generating these maps in operational remote sensing. The application-oriented polarimetric signature analyses in the literature are compiled, and several optical models are illustrated to bring out requirements of a sensor system for polarimetric mapping. By use of the concepts of Stokes parameters the descriptive specification of one sensor system is refined. The descriptive specification for a multichannel digital photometric-polarimetric mapper is based upon our experience with the present single channel device which includes the generation of polarimetric maps and pictures. High photometric accuracy and stability coupled with fast, accurate digital output has enabled us to overcome the handicap of taking sequential data from the same terrain.

NASA

H-3

HALL, D.J., R.M. ENDLICH, D.E. WOLF, and A.E. BRAIN, 1972, Objective Methods for Registering Landmarks and Determining Cloud Motions from Satellite Data, in Proceedings of the Two Dimensional Digital Signal Processing Conference, Columbia, Mo., Oct. 6-8, 1971, 9 pp.
(Stanford Research Inst., Menlo Park, Calif.)

Abstract - Cloud photographs are available from geosynchronous weather satellites at intervals of approximately 20 min. Sequences of such photographs show cloud motions over vast regions of the planet, providing a potential source of useful weather data, particularly over the oceans, since there are few weather-monitoring stations at sea. The computer programs represent objective methods that require a minimum of human assistance to compute cloud motions. Computer algorithms are described for matching the earth's disk, giving a global registration; a more precise local registration is then achieved by matching landmarks. Accurate registration is needed because the satellite cannot be given an ideal synchronous orbit and perfect attitude stability.

INSPEC

HALL, E.L., R.Y. WONG, and J. ROUGE, 1976, Hierarchical Search for Image Matching, in Proceedings of the 15th Conference on Decision and Control and Symposium on Adaptive Processes, Clearwater, Fla., Dec. 1-3, 1976, pp. 791-796.
(USAF, Space and Missile Systems Organization, El Segundo, Calif.)

Author Abstract - The problem of matching two images of the same scene produced by different sensors under different viewing conditions is important in many applications. A hierarchical method which is logarithmetically efficient is presented in this paper. Experimental results are presented for matching an image region corrupted by noise and for matching images from optical and radar sensors. The significance of this approach is that scene matching can be accomplished even in cases which are difficult for humans or standard correlation techniques and may be accomplished with greatly reduced computations.

NASA

H-5

HALL, E.L., W. FREI, and R.Y. WONG, 1977, Scene Content Analysis Program - Phase II. Final Report, 7 Jul. 1976-15 Jul. 1977, (Contr. No. F04701-76-C-0224; Rept. No. AD-A045 624/4ST), 278 pp. (University of Southern California, Dept. of Electrical Engineering, Los Angeles, Calif.)

Abstract - This report summarizes the development of map matching techniques for precision guided reentry vehicles using measurements extracted from data taken by sensors with different operating characteristics and under different viewing geometrics. The case of matching optical to side looking radar images is considered in detail. Map matching with hierarchical search was developed and practical algorithms implemented in matching scenes with a wide variety of contents. Theoretical analyses, which were subsequently verified by experiment, indicated that applications of this method have made the difficult task of optical to radar map matching possible at a computational efficiency of 3 orders in magnitude higher than current map matching methods. Map matching with this method has also resulted in a high probability of a match at a relatively low probability of false fix. Also included are analyses to determine perspective, scaling and rotational parameters from data extracted from image set. Geometric transformation for the correction of viewing geometry can be made using these parameters. Intensity transformation using sensor-dependent parameters was also developed. Practical algorithms were implemented for the corrections of the intensity of several sets of radar images.

NTIS

HARALICK, R.M., 1976, Automatic Remote Sensor Image Processing, in Digital Picture Analysis, Topics in Applied Physics, v. 11, 1976, pp. 5-63. (Kansas Univ. Center for Research, Inc., Remote Sensing Lab, Lawrence, Kans.)

Abstract - Problems associated with the preprocessing of remote sensor images are examined with attention given to multi-image normalization for viewing angle, atmospheric and intensity variations, and image registration, congruencing, and rectification. Image pattern recognition is discussed with emphasis on category and training data selection, decision rule determination, feature selection, and clustering. Image texture (optical processing methods, digital transform methods, etc.) are considered as are near real time hardware processing and software processing (multi-image formats, user oriented commands and library programs).

NASA/GEO-G

H-7

HARALICK, R.M., 1974, Texture-Tone Study with Application to Digitized Imagery. Final Technical Report, (Contr. No. DAAK02-70-C-0388; Rept. No. RSL-TR-182-6, AD-A008 030/9ST, ETL-CR-74-17), 53 pp.
(Kansas Univ. Center for Research, Inc., Remote Sensing Lab, Lawrence, Kans.; Army Engineer Topographic Labs, Fort Belvoir, Va.)

Abstract - Texture is one of the important characteristics used in identifying objects or regions of interest in an image, whether the image be a photomicrograph, an aerial photograph, or a satellite image. This report describes some easily computable textural features based on grey tone spatial dependencies and illustrates their application in category identification tasks of three different kinds of image data: photomicrographs of 5 kinds of sandstones, 1:20,000 panchromatic aerial photographs of 8 land use categories and ERTS (Earth Resources Technology Satellite) multispectral imagery containing 7 land use categories. The author uses two kinds of decision rules: one for which the decision regions are convex polyhedra (a piecewise linear decision rule) and one for which the decision regions are rectangular parallelepipeds (a MINMAX decision rule). Another application of texture analysis is with respect to camouflage design problems and the author develops a textural transform for the feature extraction of camouflage clutter.

NTIS

HARALICK, R.M. and D.E. ANDERSON, 1971, Texture-Tone Study with Application to Digitized Imagery. Interim Technical Report (Contr. No. DAAK02-70-C0388; Rept. No. CRES-TR-182-2; AD-737 722), 149 pp. (Kansas Univ. Center for Research, Inc., Remote Sensing Lab, Lawrence, Kans.)

Author Abstract - An image data set of 54 scenes was obtained from 1/8 inch by 1/8 inch areas on a set of 1:20000 scale photography. The scenes, which consisted of 6 samples from each of the nine categories (shrub, orchard, heavily wooded, urban, suburban, lake, swamp, marsh, and railroad yard) were analyzed manually and automatically. For the automatic analysis, a set of features measuring the spatial dependence of the grey tones of neighboring resolution cells was defined. On the basis of these features and a simple decision rule, which assumed that the features were independent and uniformly distributed, an identification accuracy of 70% was achieved by training on 53 samples and assigning an identification to the 54th sample and repeating the experiment 54 times.

NTIS

H-9

HARALICK, R.M. and J.D. BISSELL, 1970, Texture-Tone Study with Application to Digitized Imagery. Interim Technical Report, (Contr. No. DAAK02-C0388; Rept. No. CRINC-TR-182-1; AD-724 117), 105 pp. (Kansas Univ. Center for Research, Inc., Remote Sensing Lab, Lawrence, Kans.)

Author Abstract - The report describes initial research efforts undertaken to determine if texture, a significant but ill-defined property of virtually all substances, can be used in a practicable automated image interpretation technique. The authors attempt to establish a basis for measures which define the important qualities of texture by first considering discrete tonal features in an image as constituents of areas of homogeneity or lack of homogeneity ('unhomogeneity'). The concept of homogeneity is intended here to signify the existence of groups of similar neighboring resolution cells, which have been judged similar by some prespecified criterion. Homogeneity displays or plots are constructed by linking or connecting the similar neighboring resolution cells and ignoring all others. Unhomogeneity infers a lack of similarity of neighboring resolution cells; and an unhomogeneity plot, then, is a display of linked, dissimilar neighboring resolution cells. Digital computer algorithms were written to determine the extent of homogeneity for each resolution cell in a picture, and a group of ten (5 homogeneity and 5 unhomogeneity) on-line plots were made for each of the 36 images.

NTIS

HARALICK, R.M. and R.J. BOSLEY, 1974, Use of Feature Extraction Techniques for the Texture and Context Information in ERTS Imagery: Spectral and Textural Processing of ERTS Imagery. Final Report, 1 Aug. 1972-17 Mar. 1974, (Contr. No. NAS5-21822; Rept. No. NASA-CR-140655), 273 pp.
(Kansas Univ. Center for Research, Inc., Remote Sensing Lab, Lawrence, Kans.; NASA Earth Resources Survey Program, Washington, D.C.)

Abstract - A procedure was developed to extract cross-band textural features from ERTS MSS imagery. Evolving from a single image texture extraction procedure which uses spatial dependence matrices to measure relative co-occurrence of nearest neighbor grey tones, the cross-band texture procedure uses the distribution of neighboring grey tone N-tuple differences to measure the spatial interrelationships, or co-occurrences, of the grey tone N-tuples present in a texture pattern. In both procedures, texture is characterized in such a way as to be invariant under linear grey tone transformations. However, the cross-band procedure complements the single image procedure by extracting texture information and spectral information contained in ERTS multi-images. Classification experiments show that when used alone, without spectral processing, the cross-band texture procedure extracts more information than the single image texture analysis.

NASA/NTIS

H-11

HARALICK, R.M. and W.F. BRYANT, 1976, Documentation of Procedures for Textural/Spatial Pattern Recognition Techniques. Final Report, (Contr. No. NAS9-14453; Rept. No. NASA-CR-150995, RSL-TR-278-1), 219 pp. (Kansas Univ. Center for Research, Inc., Remote Sensing Lab, Lawrence, Kans.)

Author Abstract - A C-130 aircraft was flown over the Sam Houston National Forest on March 21, 1973 at 10,000 feet altitude to collect multispectral scanner (MSS) data. Existing textural and spatial automatic processing techniques were used to classify the MSS imagery into specified timber categories. Several classification experiments were performed on this data using features selected from the spectral bands and a textural transform band. The results indicate that (1) spatial post-processing a classified image can cut the classification error to 1/2 or 1/3 of its initial value, (2) spatial post-processing the classified image using combined spectral and textural features produces a resulting image with less error than post-processing a classified image using only spectral features and (3) classification without spatial post processing using the combined spectral textural features tends to produce about the same error rate as a classification without spatial post processing using only spectral features.

NASA/NTIS/GEO-G

HARALICK, R.M. and I. DINSTEIN, 1975, A Spatial Clustering Procedure for Multi-Image Data, in IEEE Transactions on Circuits and Systems, v. CAS-22, May 1975, pp. 440-450.
(Kansas Univ. Center for Research, Inc., Remote Sensing Lab, Lawrence, Kans.; Communications Satellite Corp., Clarksburg, Md.)

Author Abstract - A spatial clustering procedure applicable to multi-spectral image data is discussed. The procedure takes into account the spatial distribution of the measurements as well as their distribution in measurement space. The procedure calls for the generation and then thresholding of the gradient image, cleaning the threshold image, labeling the connected regions in the cleaned image, and clustering the labeled regions. An experiment was carried out on ERTS data in order to study the effect of the selection of the gradient image, the threshold, and the cleaning process. Three gradients, three gradient thresholds, and two cleaning parameters yielded 18 gradient-thresholds combinations. The combination that yielded connected homogeneous regions with the smallest variance has Robert's gradient with distance 2, threshold by its running mean, and a cleaning process that considered a resolution cell to be homogeneous if and only if at least 7 of its nearest neighbors were homogeneous.

NASA

H-13

HARALICK, R.M. and I. DINSTEIN, 1973, Texture-Tone Study. Category Maps, Gradient and Homogeneity Images. Interim Technical Report No. 5, (Contr. No. DAAK02-70-C-0388; Rept. No. CRES-TR-182-5, AD-765 526), 23 pp.
(Kansas Univ. Center for Research, Inc., Remote Sensing Lab, Lawrence, Kans.)

Author Abstract - Two scenes were selected from 1:20,000 aerial photographs in order to demonstrate generation of category maps and gradient and homogeneity images. The category maps generation used a MINMAX decision rule to identify three categories in each one of the scenes. Gradient and homogeneity images were generated using the JDATA programs. All the results were displayed on the IDECS colored monitor. Photographs of the results are provided in the report.

DDC/NASA/NTIS/ETL BIB

HARALICK, R.M. and K.S. SHANMUGAM, 1974, Combined Spectral and Spatial Processing of ERTS Imagery Data, in Remote Sensing of Environment, v. 3, no. 1, 1974, pp. 3-13.
(Kansas Univ. Center for Research, Inc., Remote Sensing Lab, Lawrence, Kans.)

Abstract - In addition to spectral features, texture is an important spatial feature used in identifying objects or regions of interest in an image. Although texture is relatively easy for human observers to recognize and describe in empirical terms, it has been extremely refractory to precise definition and analysis by digital computers. This paper describes a procedure for extracting some easily computable features for the texture of blocks of digital image data and illustrates the applications of combined textural (spatial) and spectral features for identifying the land use categories of blocks of ERTS MSS (Earth Resources Technology Satellite Multi Spectral Scanner) data. The land use classification algorithm based on textural and spectral features was developed and tested using 614 image blocks of 64x64 resolution cells derived from an ERTS image over the Monterey Bay area of the California coast line. The algorithm was applied on a training set of 314 blocks and tested on a set of 310 blocks. The overall accuracy of the classifier was found to be 83.5% on seven land use categories.

INSPEC/COMP

H-15

HARKER, G.R., and J.W. ROUSE, JR., 1977, Flood-Plain Delineation Using Multispectral Data Analysis, in Photogrammetric Engineering and Remote Sensing, v. 43, Jan 1977, (Rept No. NGL-44-001-001), pp. 81-83, 85-87.
(Western Illinois University, Macomb, Ill.; Texas A&M University, College Station, Tex.)

Author Abstract - The paper explores the application of a remote sensing technique that may permit the determination of flood-plain areas without the extensive work associated with existing techniques. Multispectral scanner data were simulated by utilizing the density differences in a color-infrared transparency for a section of the Navasota River, Texas. The transparency was taken from a low-flying aircraft and covered an area approximating a square mile. The simulated data were processed by an automatic classification technique previously developed in the remote sensing field. The technique used involves the application of the maximum likelihood rule in order to categorize the data being processed. An attempt was made to distinguish between areas known to be in the flood plain and those outside. A reasonable correlation was found between boundaries based on computer-processed multispectral data and those produced by techniques currently in use.

NASA

HAWKINS, J.K., 1971, Network Properties for Pattern Recognition. Final Report. 1 Apr. 1968-31 Mar. 1971, (Contr. No. N0014-68-C-0315; Rept. No. RR-7102, AD-722 697), 52 pp.
(Robot Research Inc., San Diego, Calif.)

Author Abstract - The report describes research conducted on the fundamental properties required of networks for automatically extracting information from complex pictorial scenes. The investigation was divided into two parts: Physical properties needed by material structures in order to process data; Mathematical properties needed by networks to extract the types of patterns occurring in pictorial data such as aerial photographs.

DDC/NTIS

H-17

HAWKINS, R.S., 1977, A New Automatic Processing Technique for Satellite Imagery Analysis. Air Force Surveys in Geophysics, (Rept. No. AFGL-TR-77-0174, AFGL-AFSG-371, AD-A049 350/2ST), 69 pp.
(Air Force Geophysics Lab, Hanscom AFB, Mass.)

Author Abstract - A new approach to the analysis of satellite imagery is presented. The central part of this approach is an algorithm which compresses information stored in the ordinary six or eight bits per picture element into only one bit. The quality of this compression is demonstrated by examples of its application to high resolution visual imagery. Both visual inspection and rms difference criterion are used for this evaluation. There are four objectives of this report which are: to review the status of processing techniques which remove redundant information, to show the need for redundance reduction in the processing of satellite images, to present the development of an algorithm for reducing it, and to show results obtained by application of the algorithm to visual imagery. Also comments are made on needed developments of the technique and its potential application to problems of analysis of satellite imagery data.

DDC/NTIS

HECHT, A.S., 1975, Parallel Optical Processing to Convert Elevation Data to Slope Maps. Phase II. Practical Considerations, (Rept. No. ETL-RN-74-12, AD-A012 790), 19 pp. For Phase I, see AD-A011 179. (Army Engineer Topographic Labs., Fort Belvoir, Va.)

Author Abstract - The considerations in designing and calibrating a coherent optical data processing system for quantitative slope computation from a transparency with amplitude transmittances as a function of surface terrain elevations are described in this report. Methods of designing the spatial filter and criteria for selecting the optical system components to minimize the errors in determining slopes are described. Procedures for calibrating the input transparency and the optical system are specified.

DDC/NASA/NTIS

H-19

HELBIG, H.S., 1973, Fast Automated Analysis and Classification of Color Pictures by Signature and Pattern Recognition Using a Color Scanner, in Proceedings of the Conference on Machine Processing of Remotely Sensed Data, West Lafayette, Ind., Oct. 16-18, 1973, pp. 4A-36 to 4A-41.
(Deutche Forschungs und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, West Germany)

Abstract - A commercial high-resolution color scanner is used with a color computer, a gradation processor, an operational amplifier, and a comparator in automatic analysis and classification of color pictures. The procedures involved are classified here as global, local, and point operations. Global operations refer to the whole picture, involving rectification, enlargement, or density transformations. Local operations are mostly used for texture and pattern recognition and are related to the scanned picture element and its surrounding area. Point operations manipulate the information of a single picture element; these are nandled in the color computer for color and signature recognition. Several operations may be carried out in the same scan. The processed picture is displayed on a B/W transparency or on a color film.

NASA/GEOREF

HENZE, J., and R. DEZUR, 1975, Interactive Digital Image Manipulation System, in NASA, Lyndon B. Johnson Space Center, NASA Earth Resources Survey Symposium, v. 1-B, pp. 1415-1435.
(ESL, Inc., Sunnyvale, Calif.)

Author Abstract - The system is designed for manipulation, analysis, interpretation, and processing of a wide variety of image data. LANDSAT (ERTS) and other data in digital form can be input directly into the system. Photographic prints and transparencies are first converted to digital form with an on-line high-resolution microdensitometer. The system is implemented on a Hewlett-Packard 3000 computer with 128 K bytes of core memory and a +7.5 megabyte disk. It includes a true color display monitor, with processing memories, graphics overlays, and a movable cursor. Image data formats are flexible so that there is no restriction to a given set of remote sensors. Conversion between data types is available to provide a basis for comparison of the various data. Multispectral data is fully supported, and there is no restriction on the number of dimensions. In this way multispectral data collected at more than one point in time may simply be treated as a data collected with twice (three times, etc.) the number of sensors. There are various libraries of functions available to the user: processing functions, display functions, system functions, and earth resources applications functions.

NASA/GEO-G

H-21

HERZOG, J.H., and R.C. RATHJA, 1973, Comparative Evaluation of Spatial Features in Automatic Land Use Classification from Photographic Imagery, in Proceedings of the Conference on Machine Processing of Remotely Sensed Data, West Lafayette, Ind., Oct 16-18, 1973, pp. 2A-69 to 2A-77.
(Oregon State Univ., Corvallis, Oreg.)

Abstract - Five spatial features have been evaluated for their applicability in automatic land use classification of photographic imagery. Data arrays of approximately 10,000 square meters were classified on the basis of an 8 x 8 point data array. Statistical features, information features, sequence features and texture features were evaluated using a distance to prototype classifier and an adaptive classifier. The results indicate approximately 70 percent accuracy in the classification.

INSPEC

HERZOG, J.H. and B. STURM, 1975, Preprocessing Algorithms for the Use of Radiometric Corrections and Texture/ Spatial Features in Automatic Land Use Classification, in Proceedings of the 10th International Symposium on Remote Sensing of Environment, Ann Arbor, Mich., Oct. 6-10, 1975, v. 2, pp. 705-724.
(Euratom and Comitato Nazionale Per L'Energia Nucleare, Centro Comune Di Richerche, Ispra, Italy)

Author Abstract - Two preprocessing techniques have been applied to data generated by the NASA LANDSAT-1 satellite over the pre-alpine region of northern Italy. In the first technique a transformation has successfully been applied to LANDSAT data to relate count rate to reflectance. The results have allowed a simple ratio classifier developed for earth based measurements to be applied to satellite data. In the second technique textural measurements have been applied to space data to identify mixed picture elements (mixels). The mixel is the inevitable result of the spatial quantization of low resolution images. Pixels which vary greatly from their neighbors have a higher priority of being mixels than pixels which are similar to their neighbors. Mixels are shown to be representative of types of land use involving high texture. Texture measurements are useful in determining land usage. By screening data to eliminate mixels improved results are obtained in test site selection, classification, and cluster analysis.

NASA/GEO-G

H-23

HIGHAM, A.D. et al, 1975, Multispectral Scanning Systems and Their Potential Application to Earth-Resources Surveys I - Basic Physics and Sensing Technology, in ESA Scientific and Technical Review, v. 1, no. 2, 1975, pp. 85-118.
(Plessey Radar, Ltd., Havant, Hants., and Stoke Poges, Bucks., England)

Author Abstract - A summary is given of the various processes affecting the interaction of radiation and matter that give rise to useful information about the surface of the Earth. The methods of sensing this information are reviewed along with the properties of specific materials of interest, the processing of the data acquired by a multispectral scanning system, and the applications to which such a system may be directed.

NASA

HITCHCOCK, H.C. and R.M. HOFFER, 1974, Mapping a Recent Forest Fire with ERTS-1 MSS Data, in Remote Sensing of Earth Resources, Proceedings of the 3rd Conference on Earth Resources Observation and Information Analysis System, Tullahoma, Tenn., Mar. 25-27, 1974, v. 3, pp. 449-461.

Author Abstract - Accurate fire boundary delineation provides essential information to forest managers in allocating suppression costs and planning regeneration efforts. The objective of this study was to test the capability of computer-aided analysis of ERTS-1 MSS data to accurately define the boundary of a recent forest fire and to discriminate spectral classes within the perimeter. Two frames of ERTS-1 MSS data were selected for analysis of the Moccasin Mesa fire in Mesa Verde National Park. Data sets were collected one-half growing season and one full growing season after the fire. Results indicate that computer-aided analysis of ERTS-1 MSS data has the capability for accurately delineating fire boundaries and determining acreage of the burned area. Distinct spectral classes may also be defined within the fire perimeter.

NASA

H-25

HOFFER, R.M., 1975, Computer-aided Analysis of Skylab Multispectral Scanner Data in Mountainous Terrain for Land Use, Forestry, Water Resource, and Geologic Applications. Final Report, 1 Apr. 73-31 Dec. 75, (Rept. No. LARS-IN-121275), 398 pp. (Purdue Univ., Lab. for Applications of Remote Sensing, West Lafayette, Ind.)

Abstract - One of the most significant results of this Skylab research involved the geometric correction and overlay of the Skylab multispectral scanner data with the LANDSAT multispectral scanner data, and also with a set of topographic data, including elevation, slope, and aspect. The Skylab S192 multispectral scanner data had distinct differences in noise level of the data in the various wavelength bands. Results of the temporal evaluation of the SL-2 and SL-3 photography were found to be particularly important for proper interpretation of the computer-aided analysis of the SL-2 and SL-3 multispectral scanner data. There was a quality problem involving the ringing effect introduced by digital filtering. The modified clustering technique was found valuable when working with multispectral scanner data involving many wavelength bands, and covering large geographic areas.

NASA/GEO-G

HOFFER, R.M., 1974, Techniques for Computer-Aided Analysis of ERTS-1 Data, Useful in Geologic, Forest and Water Resource Surveys--Colorado Rocky Mountains, in NASA. Goddard Space Flight Center. 3rd ERTS-1 Symposium, v. 1, sec. B, (Rept. No. NGL-15-005-112), pp. 1687-1708.
(Purdue Univ., Lab for Applications of Remote Sensing, West Lafayette, Ind.)

Author Abstract - Forestry, geology, and water resource applications were the focus of this study, which involved the use of computer-implemented pattern-recognition techniques to analyze ERTS-1 data. The results have proven the value of computer-aided analysis techniques, even in areas of mountainous terrain. Several analysis capabilities have been developed during these ERTS-1 investigations. A procedure to rotate, deskew, and geometrically scale the MSS data results in 1:24,000 scale printouts that can be directly overlayed on 7 1/2 minutes U.S.G.S. topographic maps. Several scales of computer-enhanced "false color-infrared" composites of MSS data can be obtained from a digital display unit, and emphasize the tremendous detail present in the ERTS-1 data. A grid can also be superimposed on the displayed data to aid in specifying areas of interest.

NASA

H-27

HOFFER, R.M., P.E. ANUTA, and T.L. PHILLIPS, 1971, Multiband and Multiemulsion Digitized Aerial Photographs. Automatic Processing by Digital Computer Techniques and Statistical Pattern Recognition Algorithms, in American Society of Photogrammetry, American Congress on Surveying and Mapping Convention, San Francisco, Calif., Sept. 10, 1971, pp. 989-1001. (Purdue University, West Lafayette, Ind.)

Author Abstract - Automatic data processing (ADP) techniques using a digital computer for data handling and analysis have allowed quantitative examination of aerial photography. Scanning microdensitometer techniques were utilized to digitize both multiband and multiemulsion photography. These digital density data from 1:120,000 scale aerial photos were spatially registered by computer and then analyzed, using statistical pattern recognition algorithms. The feasibility for automatic recognition of several cover types is indicated. Similar results were obtained from the digitized multiband and multiemulsion photographic data.

NASA

HOFFMANN, R.J., 1973, Infrared Reconnaissance (IRR) Support to U.S. Geological Survey. Progress Report, 1 Jun. 72 - 28 Sept. 73, (Rept. No. DF733580). (Rome Air Development Center, Griffiss AFB, N.Y.)

Abstract - The objective of this effort was to investigate the potential use of automated processing techniques that are available under the Spectral Combinations for Reconnaissance Exploitation (SCORE) program to land use and other large area survey applications. Nine lens photography and ERTS-A photography over the northeast was digitized and analyzed to determine the potential of digital pattern recognition techniques for identification of four broad categories - (1) vegetation, (2) water, (3) bare soil, and (4) man-made areas. Numerous selected test sites were overflown and the nine lens photography digitized and classification logic designed. The results of this experiment were promising and demonstrated the potential use of interactive extraction and classification design to an earth resource application. Program is now completed. No final report will be generated.

HEL-RSG

H-29

HOFMANN, D., 1978, Kartoscan, A New Digital Scanner for Cartography, 5 pp.
(Messerschmitt-Boelkow-Blohm G.M.B.H., Munich, West Germany)

Abstract - A flat-bed scanner was developed for the digitizing of all kinds of graphic originals. The scanner is equipped with the latest, highly resolving photo sensors scanning the original in raster and areal form. Extensive software packages complete the device, thus making it a universally usable aid to cartography.

NASA/NTIS

HONEY, F.R., A. PRELAT, and R.J.P. LYON, 1974, STANSORT: Stanford Remote Sensing Laboratory Pattern Recognition and Classification System, in Proceedings of the 9th International Symposium on Remote Sensing of Environment, Univ. of Michigan, Ann Arbor, Mich., Apr. 15-19, 1974, v.2, pp. 897-905. (Stanford Univ., School of Earth Science, Calif.)

Abstract - The principal barrier to routine use of the ERTS multispectral scanner computer compatible tapes, rather than photointerpretation examination of the images, has been the high computing costs involved due to the large quantity of information (4 times 10 to the 6th power bytes) contained in a scene. STANSORT alleviates this problem, providing an extremely rapid, flexible and low cost tool for data reduction, scene classification, species searches and edge detection. The primary classification procedure, utilizing a search, with variable gate widths, for similarities in the normalized, digitized spectra is described along with the more rigorous statistical classification procedures.

COMP

H-31

HORD, R.M. and N. GRAMENOPOULOS, 1974, Edge Detection and Regionalized Terrain Classification from Satellite Photography, in Computer Graphics and Image Processing, v. 4, no. 2, 1975, pp. 184-199. (Itek Corporation, Lexington, Mass.)

Abstract - A new technique has been developed to perform automatic terrain classification based on edge detection of terrain regions characterized by spatial signatures. Boundaries of the regions are developed by derivative operations on digitized photographic imagery. The boundary development starts with a low-resolution version of the image (25 X reduction). The boundaries obtained (coarse boundaries between large regions) are employed as a plan for the next higher resolution (5 X reduction) boundary map which is then used as a plan for the fine boundary map at the original image resolution. At each step, topographic constraints are imposed: the boundaries must be continuous and end on intersections. The end result is the partitioning of the image into regions. Finally, spatial pattern recognition is carried out in small regions of the original image selected by a rectangular grid. By this operation it is possible to classify the regions enclosed by the boundaries and, in addition, to correct errors in the boundaries. The technique described has the following advantages: 1) only 25% of the image is subjected to the spatial pattern recognition, which is time-consuming, 2) better classification results are achieved than if only spatial pattern recognition were applied to the entire image, and 3) the classified regions are accurately delineated.

Handsearch

HORD, R.M., N. GRAMENOPOULOS, and Y.H. KATZ, 1971, Automatic Terrain Classification from Photography, in Proceedings of the Seminar on Remote Sensing of Earth Resources and the Environment, Palo Alto, Calif., Nov. 1971, pp. 41-48.
(Society of Photo-Optical Instrumentation Engineers; National Oceanic and Atmospheric Administration; American Meteorological Society)

Abstract - As the acquisition of aerial photographic imagery continues to grow at a rapid rate, automatic data extraction becomes more and more desirable. To this end, an image processing system is being developed to computerize terrain classification. A laser scanner has been used to digitize Apollo 9 imagery of the Salton sea area. A signature algorithm has been specified allowing the assignment of small image blocks to specific terrain categories. Results of automatic classification and manual photo-interpretation are compared. Categories considered are cultivated terrain, uncultivated terrain, cloud covered terrain, and water. Assignment is based on a single black and white transparency in each case. The assignments are displayed as overwritten alphabetic annotation on the original image. Problems are discussed.

INSPEC

H-33

HOWARD, G.E., 1975, Adaptive Optical/Electronic Hybrid Processing. Progress Report, 1 Jul. 72 - 20 Mar. 75, (Rept. No. DF095940).
(Air Force Avionics Lab, Wright Patterson AFB, Ohio)

Abstract - The objective of this research is to establish an inhouse capability in adaptive pattern recognition. Emphasis will be placed first on feature determination, and then on feature extraction. A coherent optical data processor will be interfaced with a PDP 11/20 minicomputer. Feedback loops from the PDP 11/20 will control the size and the scanning path of the optical processor laser beam. The PDP 11/20 will also be programmed to rapidly compute various parameter values of the Fourier spectra information it receives from the optical processor/minicomputer interface device. Inhouse work dealing with adaptive optical/electronic hybrid pattern recognition has been terminated. A pattern recognition algorithm was partially developed. This algorithm utilized a guided accelerated random search technique obtained from Adaptronics, Inc., on a six-month basis. The algorithm, together with a performance assessment subroutine, was designed to perform feature extraction on digitized optical diffraction patterns. Although the algorithm was debugged and run on the CDC-6600 computer using simple input data, the project was terminated before results could be obtained using sampled diffraction pattern data.

HEL-RSG

HSU, S.-Y., 1975, Automated Pattern Recognition with Thermal IR Imagery, in Photogrammetric Engineering and Remote Sensing, v. 41, no. 5, May, 1975, pp. 647-651. (State Univ. of New York, Binghamton, N.Y.)

Abstract The use of both day-and-night thermal-infrared imagery density values in a multivariate model for automatic pattern recognition is proposed. The analytical model is discriminatory analysis, utilizing the discriminatory function, derived from the day-and-night density vectors, for pattern recognition and mapping purposes. For mapping purposes, two models are developed further. Results indicate that an accuracy rate of well over 85% can be obtained for automatic mapping purposes. A low-cost automatic imagery interpretation system can be obtained.

GEO-G/NASA/COMP

H-35

HUANG, T.S., and K.-S. FU, 1977, Image Understanding and Information Extraction. Final Technical Report, 1 Nov. 76 - 31 Oct. 76, (Contr. No. F30602-75-C-0150, ARPA Order-2893; Rept No. AD-A040 138, RADC TR-77-102), 178pp.
(Purdue Univ., School of Electrical Engineering, Lafayette, Ind.)

Abstract - This report summarizes the results of the research program on Image Understanding and Information Extraction at Purdue University supported by the Defense Advanced Research Projects Agency. The objective of our research is to achieve a better understanding of image structure and to use this knowledge to develop techniques for image analysis and processing tasks, especially information extraction. Our emphasis is on syntactic decomposition and recognition of imagery based on scene analysis. It is our expectation that this research will form a basis for the development of technology relevant to military applications of machine extraction of information from aircraft and satellite imagery.

DDC

HUBBARD, R.G., 1975, Color Detection Processing. Final Technical Report, (Contr. No. F30602-73-C-0274; Rept. No. AD-A007 783/4ST; RADC-TR-75-28), 61 pp. (Hamilton Standard, Windsor Locks, Conn.; Rome Air Development Center, Griffiss AFB, N.Y.)

Abstract - In the computer operation of converting raster scan data to a lineal format for the purposes of cartographic image processing, the accuracy of the output lineal data, compared to the graphic source, is influenced by the quality of the input raster data. Raster-scan data quality is characterized by the extent to which microscale image variations are converted into a consistent, macroscale image representation. The objective of the work described herein was to determine that the flexible capability and functional capacity of a computer-centered raster scan process was a practical approach which could enhance the raster data product as an input to the lineal conversion. The effort included the study and analysis of color discrimination techniques and data editing procedures applicable to computer usage, as well as the implementation of these functions in an experimental test system including the Automatic Color Separation Device.

NTIS

H-37

HUMISTON, H.A., and G.E. TISDALE, 1973, A Peripheral Change Detection Process, in Proceedings of the American Society of Photogrammetry Symposium on Management and Utilization of Remote Sensing Data, Sioux Falls, S. Dak., 1973, pp. 413-426.

Abstract - A quick-look change detection function is discussed. The method incorporates an on-line image registration capability which is not only independent of relative orientation and scale but also eliminates the need for identifiable control points within the images. Television input and output functions for this system incorporate self-calibrations, enabling precision control of scan linearities as well as photometry. The precision and speeds foreseeable suggest additional applications to the main data stream to be a cost-effective measure for upgrading the quality and quantity of the image products produced by an operational surveillance system.

GEO-G

HUNT, B.R., 1977, Automatic Methods in Image Processing and Their Relevance to Map-Making. (Grant No. DAAG29 77 G0175; Rept. No. DA0F9036).
(University of Arizona, Tucson, Arizona)

Abstract - A plan is presented to systematically examine the fundamental problems of automated cartography with the objective of developing theory and then models for automated image evaluation, automated model performance evaluation and automated image quality improvement. Since accurate topographic maps are essential to effective Army operations in combat situations, the research is directly related to the mapping and sensing mission of the Engineer Topographic Laboratories. Image decomposition models will be developed to isolate particular image defects: the interaction of hardware systems and their computational analogs with the image decomposition models, the enhancement potential, class of enhancement processes, and methods of estimating control parameters for enhancement algorithms will be developed.

DDC-WU

H-39

HUNT, B.R., 1978, Optical Implementations of Image Bandwidth Compression Schemes, (Contr. No. DF044160; AFOSR-3024-76; Rept. No. GQF 44160 2)
(Univ. of Arizona, School of Engineering, Tucson, Ariz.)

Abstract - An increasing number of military systems are employing visual communication processes in the execution of command and control, target acquisition, identification, and surveillance. Transmission of the high information content of visual images complicates the problem of an overcrowded electromagnetic spectrum; however, digital image bandwidth compression schemes have been developed to take advantage of the information redundancy of images. It would be desirable if an image bandwidth compression scheme could be developed that did not have the requirement for complex digital architecture and was capable of being extended to higher data rates and larger images. The proposed effort will demonstrate that two different image compression schemes can be implemented by optical means. This research advances optical image processing for command and control systems. An optical differential pulse code modulation (DPCM) method and an optical interpolation scheme will be simulated digitally. Their performances will be evaluated for various design alterations in order to determine the advisability of pursuing the optical implementation of either compression scheme. With respect to the DPCM scheme, emphasis will be placed on investigating various feedback structures, while for the interpolation scheme, both stochastic and deterministic basis functions will be investigated for use in the interpolator.

SSIE

IDELSOHN, J.M., 1970, A Learning System for Terrain Recognition, in Conference on Pattern Recognition in Photogrammetry, Alexandria, Va., Jan 9, 1970; Pattern Recognition (GB) v. 2, no. 4, Dec. 1970, pp. 293-301.
(Bendix Research Labs., Southfield, Mich.; American Society of Photogrammetry; Pattern Recognition Society)

Abstract - A system is described which automatically classifies terrain types from photography. Input is conventional panchromatic single-frame aerial photography of the earth. A flying-spot scanner converts this input to a time-varying video signal suitable for processing by the pattern recognition system. Processing consists of a series of analog and digital operations to arrive at a terrain classification based on spatial texture in the region of the input point. A learning strategy enables the system to refine its processing operations in order to improve classification performance with time. Test results are summarized.

INSPEC

J-1

JANCAITIS, J.R., W.R. MOORE, 1978, Near Real Time Application of Digital Terrain Data in a Minicomputer Environment, (Rept. No. ETL-0142, AD-A054 008/8SL), 30 pp. (Army Engineer Topographic Labs, Fort Belvoir, Va.)

Author Abstract - Two developments have combined to significantly impact the growing number of applications dependent upon digital terrain elevation data, mathematical terrain modeling, and minicomputer growth. Digital representation of terrain form has previously required vast amounts of mass storage with the relatively slow speed data access associated with large databases. A technique has been developed for compact digital storage of elevation data which also decreases the data access times significantly, a polynomial terrain model. Also, the minicomputer industry has been experiencing dramatic increases in the processing speeds and digital storage capabilities along with steadily declining costs. Preliminary results of a recently initiated study into the impact of these developments on utilization of digital terrain elevation data is presented.

NTIS

J-1A

JANCAITIS, J.R., 1978, Elevation Data Compaction by Polynomial Modeling, (Rept. No. ETL-0140, AD-A054 003), 45 pp. (Army Engineer Topographic Labs., Ft. Belvoir, Va.)

Abstract - Ongoing research is described, directed toward near-term production implementation of digital data compression of terrain elevation information. The important data characteristics, major applications, and compression needs are discussed, followed by the various published terrain representations, their capabilities and limitations. An overview of the Polynomial Terrain Model's characteristics and construction is presented as well as the development plan identified for production implementation of the polynomial modeling technique. The status of various phases of this development are reported. The results showed that the Polynomial Matrix method is the most promising of the various digital terrain formats (DFT).

ETL

JAYROE, R.R., JR., 1973, Unsupervised Spatial Clustering with Spectral Discrimination, (Rept. No. NASA-TN-D-7312; M-107), 91 pp.
(National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.)

Author Abstract - The development of a computer program is reported for extracting features from remotely sensed data presented in digital image form. This computer program requires no human supervision or prejudgment and operates unassisted on the raw digital data. A condensed general background is included on remote sensing of earth features and a short synopsis on some of the most commonly used types of feature extraction techniques. Results obtained from the unsupervised feature extraction computer program along with a description and listing of the computer program are presented.

NASA/NTIS

J-3

JAYROE, R.R., JR. and D. UNDERWOOD, 1977, Vector Statistics of Landsat Imagery, (Rept. No. NASA-TM-78149), 19 pp. (National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.)

Abstract - A digitized multispectral image, such as LANDSAT data, is composed of numerous four dimensional vectors, which quantitatively describe the ground scene from which the data are acquired. The statistics of unique vectors that occur in LANDSAT imagery are studied to determine if that information can provide some guidance on reducing image processing costs. A second purpose of this report is to investigate how the vector statistics are changed if that information can be useful in choosing one processing approach over another.

NTIS/NASA

JENSEN, J.R., 1977, Digital Land Cover Mapping Using Layered Classification Logic and Physical Composition Attributes, in The American Cartographer, v. 5, no. 2, 1978, pp. 121-132.
(Univ. of Georgia, Athens, Ga.)

Abstract - Imagery created by satellite multispectral scanning systems have generated widespread interest for application to land cover mapping. The energy sensed in each spectral band can be interpreted visually, or it can be used as a feature in a machine-assisted pattern recognition process. Simultaneous visual interpretation of numerous multispectral images often becomes impractical, especially as the area studied increases; hence, great emphasis has been placed on computer techniques for improving the repeatability, accuracy, and timeliness of land cover mapping. In this light, a parallelepiped layered classification incorporating physical composition attributes was developed and tested against the traditional Boolean logic parallelepiped decision rule. LANDSAT digital picture elements (pixels) of Goleta, California, were interactively filtered through a series of decision layers (solid, liquid, organic, inorganic, mixture solid/liquid, and mixture organic/inorganic) prior to being assigned to land use classes. Evaluation of the layered classification versus the traditional parallelepiped classification revealed a statistically significant difference between errors of commission and no significant difference between errors of omission. Errors of commission create serious problems in traditional parallelepiped classifications; consequently the hybrid technique exhibits potential for improved land cover mapping.

Handsearch

J-5

JOYCE, A.T., 1974, Computer-Implemented Land Use Classification with Pattern Recognition Software and ERTS Digital Data--Mississippi Coastal Plains, in ITS 3rd ERTS-1 Symposium, v. 1, Sect. A, pp. 331-337. (National Aeronautics and Space Administration, Mississippi Test Facility, Bay Saint Louis, Miss.)

Author Abstract - Significant progress has been made in the classification of surface conditions (land uses) with computer-implemented techniques based on the use of ERTS digital data and pattern recognition software. The supervised technique presently used at the NASA Earth Resources Laboratory is based on maximum likelihood ratioing with a digital table look-up approach to classification. After classification, colors are assigned to the various surface conditions (land uses) classified, and the color-coded classification is film recorded on either positive or negative 9 1/2 in. film at the scale desired. Prints of the film strips are then mosaicked and photographed to produce a land use map in the format desired. Computer extraction of statistical information is performed to show the extent of each surface condition (land use) within any given land unit that can be identified in the image. Evaluations of the product indicate that classification accuracy is well within the limits for use by land resource managers and administrators. Classifications performed with digital data acquired during different seasons indicate that the combination of two or more classifications offer even better accuracy.

NASA/GEOREF

KALENSKY, Z., 1975, ERTS Thematic Map from Multidate Digital Images, in Proceedings of Symposium on Remote Sensing and Photo Interpretation, Banff, Alberta, Canada, Oct. 7-11, 1974, v. 2, pp. 767-785.
(Canadian Forestry Service, Forest Management Institute, Ottawa, Canada)

Abstract - Multidate and multispectral ERTS-1/MSS digital images were combined to produce thematic maps of the Larose forest test area. Two pattern recognition systems based on the maximum likelihood decision rule were used to classify calibrated earth radiance data into seven subscenes: (1) four-channel system for multispectral classification of images recorded at one date; and (2) twelve-channel system for multidate and multispectral classification of images recorded at three dates. Classified digital images were recorded on computer compatible tapes and printed by an electron beam image recorder to produce separation film transparencies for color photomaps. Digital images were also printed by a line printer and displayed as computer printouts with alphabetically coded subscenes. Estimates of classification accuracy for each thematic map and three subscenes (agricultural, coniferous and deciduous forest) are presented in summary tables.

NASA

K-2

KAN, E.P., 1976, A New Computer Approach to Map Mixed Forest Features and Postprocess Multispectral Data, in Proceedings of the American Society of Photogrammetry, and American Congress on Surveying and Mapping, Fall Convention, Seattle, Wash., Sept. 28 - Oct 1, 1976, (Contr. No. NAS9-12200), pp. 386-401. (Lockheed Electronics, Co., Inc., Aerospace Systems Div., Houston, Tex.)

Abstract - A computer technique for mapping mixed softwood and hardwood stands in multispectral satellite imagery of forest regions is described. The purpose of the technique is to obtain smoother resource maps useful in timber harvesting operations. The computer program relies on an algorithm which assesses the size and similarity of adjacent sections on satellite imagery (LANDSAT-1 data is used) and constructs, through an iteration of the basic algorithm, a more general map of timber mixtures, eliminating the mottled appearance of the raw imagery. Despite difficulties in the experimental analysis of a Texas forest, apparently due to relatively low resolution of the LANDSAT data, the computer classification approach outlined is suggested as a generally applicable method of creating serviceable maps from multispectral imagery.

NASA/GEO-G

KAN, E.P., D.L. BALL, J.P. BASU, and R.L. SMELSER, 1975, Data Resolution Versus Forestry Classification and Modeling, in Proceedings of the 2nd Symposium on Machine Processing of Remotely Sensed Data, West Lafayette, Ind., Jun. 3-5, 1975, (Contr. No. NAS9-12200), pp. 1B-24 to 1B-36. (U.S. Department of Agriculture, Forest Service, Lufkin, Tex.; Lockheed Electronics Co., Houston, Tex.)

Author Abstract - This paper examines the effects on timber stand computer classification accuracies caused by changes in the resolution of remotely sensed multispectral data. This investigation is valuable, especially for determining optimal sensor and platform designs. Theoretical justification and experimental verification support the finding that classification accuracies for low resolution data could be better than the accuracies for data with higher resolution. The increase in accuracy is constructed as due to the reduction of scene inhomogeneity at lower resolution. The computer classification scheme was a maximum likelihood classifier.

NASA

K-4

KAWAMURA, J.G., 1971, Automatic Recognition of Changes in Urban Development from Aerial Photographs, in IEEE Transactions on Systems, Man, and Cybernetics, July 1971, v. SMC-1, no. 3, pp. 230-9.
(TRW Systems Group, Redondo Beach, Calif.)

Abstract - A computer is programmed to detect changes in two aerial photographs of the same region taken at different times. A nonlinear registration technique is used to partition the photographs into cell pairs. Three feature measurements called the two-dimensional correlation coefficient, the average entropy change per picture element, and the high-intensity probability change per picture element are calculated for each cell pair. The pattern recognition system is trained on a set of learning samples and then tested on an independent set of test samples. Experimental error probability curves are presented as a measure of the system effectiveness.

COMP

KEDAR, E.Y., and S.-Y. HSU, 1972, Applications of the Discriminant Function in Automatic Pattern Recognition of Side-Looking Radar Imagery, in Proceedings of the Society of Photo-Optical Instrumentation Engineers Seminar on Imaging Techniques for Testing and Inspection, Los Angeles, Calif., Feb. 1972, pp. 145-8 (State Univ. of New York, Binghamton, N.Y.; American Society for Testing and Materials; American Society for Non-destructive Testing)

Abstract - An automatic pattern recognition system of SLR imagery is suggested, based upon discriminatory analyses on the isodensitracer and TV scanned data.

INSPEC

K-6

KEDAR, B.Y. and S.-Y. HSU, 1971, Computerized Analytical System for Side-Looking Radar Imagery Interpretation by Isodensitracer Scanned Density Data Multivariate Analysis Applied to Environmental Discrimination, in Proceedings of the Electro-Optical Systems Design Conference, New York, N.Y., Sept. 14-16, 1971, pp. 363-367.
(New York State University, Binghamton, N.Y.)

Abstract - An attempt was made to develop an automatic computerized analytical system for side-looking radar (SLR) imagery interpretation by multivariate discriminatory analysis, utilizing isodensitracer (microdensitometer) scanned density data. In terms of sensor technology, SLR uses an active microwave system to detect environmental features. Its imagery is the echo responding to the transmitted radar signals. It is, therefore, composed of thousands of individual resolution cells, representing the 'return' and 'no-return' of the radar signals striking at single and composite terrestrial features.

NASA

KELLY, R.E., P.R.H. MCCONNELL, and S.L. MILDENBERGER, 1977, The Gestalt Photomapping System, in Photogrammetric Engineering and Remote Sensing, v. 43, Nov. 1977, pp. 1407-1417.
(Gestalt International, Stittsville, Ontario, Canada)

Author Abstract - The Gestalt photomapping system is made up of the GPM II and the GPM plotting system. The GPM II is a computer-controlled, auto-correlating, analytical photomapper. It is composed of two scanners, an automatic image correlator, a control computer, an operator's console, and one or two printers. A typical stereomodel is completed automatically in less than an hour and a half after a 10 minute operator-assisted analytical orientation. Principal topographic output consists of a 700,000-point digital terrain model (DTM) on magnetic tape; planimetric output consists of an orthophoto on 20 x 25 CM stable-base film. The GPM plotting system is an off-line automatic DTM processing system. It consists of a disk-based minicomputer and plotter. Smoothed contours and slope maps may be plotted at map scale with annotation in less than an hour and a half. A GPM II orthophotograph and GPM plotting system contours may be combined without editing by using conventional photographic techniques to produce a reproduction-quality contoured orthophoto map in less than a day.

NASA

K-8

KENNEDY, J.G. and A.N. WILLIAMSON, 1976, A Technique for Achieving Geometric Accordance of LANDSAT Digital Data. Final Report, Period Ending FY 76, (Contr. No. 4A0-61101-A-91-D; Rept. No. AD-B013354L, WES-MP-M-76-16), 94 pp.
(Army Engineer Waterways Experiment Station, Vicksburg, Miss.)

Author Abstract - This report presents techniques for precisely overlaying and registering LANDSAT digital data for analysis of time-dependent phenomena. A practical application of the technique is demonstrated by digitally overlaying two LANDSAT scenes of an area, detecting changes that occurred during the intervening period between scenes, and displaying the results as overlays to 1:250,000-scale maps having a UTM projection. Appendix A to this report presents a method for converting LANDSAT computer-compatible tapes to images on photographic film. Appendices B and C present documentation of two of the computer programs used in this study.

NASA

KETTIG, R.L., 1975, Computer Classification of Remotely Sensed Multispectral Image Data by Extraction and Classification of Homogeneous Objects, (Contr. No. NAS9-14016; Rept. No. NASA-CR-147403, LARS-IN-050975), 194 pp.
(Purdue Univ., Lab. for Applications of Remote Sensing, Lafayette, Ind.)

Author Abstract - A method of classification of digitized multispectral images is developed and experimentally evaluated on actual earth resources data collected by aircraft and satellite. The method is designed to exploit the characteristic dependence between adjacent states of nature that is neglected by the more conventional simple-symmetric decision rule. Thus contextual information is incorporated into the classification scheme. The principle reason for doing this is to improve the accuracy of the classification. For general types of dependence this would generally require more computation per resolution element than the simple-symmetric classifier. But when the dependence occurs in the form of redundance, the elements can be classified collectively, in groups, thereby reducing the number of classifications required.

NASA/NTIS/GEO-G

K-10

KETTIG, R.L., and D.A. LANDGREBE, 1975, Classification of Multispectral Image Data by Extraction and Classification of Homogeneous Objects, (Rept. No. LARS-IN-062375), 19 pp.
(Purdue Univ., Lab. for Applications of Remote Sensing, West Lafayette, Ind.)

Abstract - A method of classification of digitized multispectral image data is described, designed to exploit a particular type of dependence between adjacent states of nature that is characteristic of the data. The advantages of this, as opposed to the conventional per point approach, are greater accuracy and efficiency, and the results are in a more desirable form for most purposes.

GEO-G

KEUPER, H.R., R.W. PEPLIES, and R.P. GILLOOLY, 1977, Photomorphic Analysis Techniques: An Interim Spatial Analysis Using Satellite Remote Sensor Imagery and Historical Data, (Contr. No. NAS8-31329; Rept. No. NASA-CR-150227, ERRA-74-17(R)-Y), 268 pp. (Environmental and Regional Research Associates, Inc., Johnson City, Tenn.)

Abstract - The use of machine scanning and/or computer-based techniques to provide greater objectivity in the photomorphic approach was investigated. Photomorphic analysis and its application in regional planning are discussed. Topics include: delineation of photomorphic regions; inadequacies of existing classification systems; tonal and textural characteristics and signature analysis techniques; pattern recognition and Fourier transform analysis; and optical experiments. A bibliography is included.

NTIS

K-12

KIRKHAM, R.G. and M.R. STEVENSON, 1976, Computer Generated Gridding of Digital Satellite Imagery, in Remote Sensing of Environment, v. 5, no. 3, 1976, pp. 215-224.
(Inter-American Tropical Tuna Commission, c/o Scripps Inst. of Oceanography, La Jolla, Calif.)

Abstract - A method is discussed whereby geographical grid benchmarks, corresponding to the elements of a given grid-coordinate matrix, may be entered into a digital-image field by a computer line-printer. A listing is presented of the required Fortran subroutine, along with samples of the output products and some estimates of plotted grid coordinate accuracy.

Handsearch

KIRVIDA, L., 1976, Texture Measurements for the Automatic Classification of Imagery, in IEEE Transactions on Electromagnetic Compatibility, v. EMC-18, Feb. 1976, (Contr. No. NAS5-21866), pp. 38-42. (Honeywell, Inc., Systems and Research Div., Minneapolis, Minn.)

Author Abstract - The stated purpose is to demonstrate the applicability of texture measurements for making distinctions between classes of imagery. Multispectral images obtained from aircraft and satellites have been successfully delineated into land use classes on the basis of density in the different spectral bands. However, spatial patterns can add additional information to improve classification accuracy. A comparison is made between the results obtained using five texture algorithms for separating land use classes using ERTS imagery. The transforms evaluated are the Karhunen-Loeve, the fast Fourier, the Walsh-Hadamard, the slant, and a digital matched filter.

NASA

K-14

KLEMAS, V., D. BARTLETT, R. ROGERS and L. REED, 1976,
Coastal Zone Classification from Satellite Imagery,
(Contr. No. NAS5-20983), 3 pp.
(Delaware Univ., Newark College of Marine Studies;
NASA Earth Resources Survey Program, Washington, D.C.;
Bendix Aerospace Systems Div., Ann Arbor, Mich.)

Abstract - Studies of cover distribution along Delaware's coast, especially in tidal wetlands, were made, using semi-automated analysis of LANDSAT-1 MSS digital data. Cover maps with eleven vegetation and other cover categories were produced with accuracy of identification above 80% in all categories. Recent studies have tested a new technique for training automated analysis which uses ground measured reflectance and atmospheric correction techniques to derive signatures for specific categories in preference to the relative radiance signatures derived from training sets within LANDSAT data itself. Initial tests using a four category scheme indicate that training data based on absolute measured reflectance and atmospheric correction of LANDSAT data can produce comparable accuracy of categorization to that achieved using more conventional relative radiance training. The analysis of the same four categories produced average categorization accuracies of 82.1% by conventional relative radiance training and 81.9% by use of absolute reflectance signatures.

NTIS

AD-A076 148 LOGICAL TECHNICAL SERVICES CORP VIENNA VA F/G 14/5
AUTOMATIC FEATURE EXTRACTION: AN ANNOTATED BIBLIOGRAPHY.(U)
MAY 79 DAAK70-78-C-0195
UNCLASSIFIED ETL-0189 NL

3 OF 5
AD
A076148

KOTHE, K.R., 1972, Research and Development Program for Military Geographic Information System Using Airborne Radar and Multispectral Photographic Data, in AGARD Propagation Limitations in Remote Sensing, 36 pp. (Army Engineer Topographic Labs., Fort Belvoir, Va.)

Author Abstract - The objectives of the research and development program are identified as collection systems, data reduction systems and information systems. To improve data collection capabilities, work is described associated with sidelooking airborne radar and color multiband photographic systems. To improve the data reduction, research and development leading to automated image data extraction capability is reviewed. Then the development of a military geographic information system with an example output is outlined in relation to an overall concept. In conclusion, it appears the research and development objectives can be attained to implement the concept of operations in the 1985 time frame.

NASA/NTIS

K-16

KRISTOF, S.J., M.F. BAUMGARDNER, and C.J. JOHANNSEN, 1974, Spectral Mapping of Soil Organic Matter, in International Telemetering Conference Journal, no. 4, 1974, (Rept. No. NGL-15-005-112), pp. 479-489.
(Purdue University, Lafayette, Ind.; Missouri University, Columbia, Mo.)

Author Abstract - Multispectral remote sensing data were examined for use in the mapping of soil organic matter content. Computer-implemented pattern recognition techniques were used to analyze data collected in May 1969 and May 1970 by an airborne multispectral scanner over a 40-km flightline. Two fields within the flightline were selected for intensive study. Approximately 400 surface soil samples from these fields were obtained for organic matter analysis. The analytical data were used as training sets for computer-implemented analysis of the spectral data. It was found that within the geographical limitations included in this study, multispectral data and automatic data processing techniques could be used very effectively to delineate and map surface soils areas containing different levels of soil organic matter.

NASA

KRITIKOS, G., B. SAHAI, and E. TRIENDL, 1975, Mapping of Water Bodies in Northern Germany from ERTS Tapes, (Rept. No. DO699060), 13 pp.
(Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, West Germany)

Abstract - Computer-compatible magnetic tapes carrying ERTS MSS data pertaining to northern Germany were examined with the aim of making a classification map of the water bodies in the region. A digital picture processing system was used to reconstruct and process the pictures. The water bodies that are not clearly distinguishable in the individual spectral bands because of unwanted background such as clouds and shadows can be demarcated clearly by taking the difference between intensities in different spectral bands. Using ratio mapping and other techniques, an automatic classification map of the water bodies in the region has been prepared.

NASA

K-18

KUNKEL, W.A., 1974, Burke County Wheat Feasibility Study, (Contr. No. NAS9-12200; Rept. No. NASA-CR-140249, LEC-3783), 17 pp.
(Lockheed Electronics Co., Aerospace Systems, Div., Houston, Tex.)

Author Abstract - A feasibility study was conducted to determine whether wheat could be distinguished from other small grain crops in a selected spring wheat growing area in Burke County, North Dakota using a maximum likelihood classification program and ERTS 1 multispectral band scanner data. ERTS 1 data scenes were selected from passes made on June 5, 1973 and June 23, 1973. The Univac 1108 computer and the LARSYS pattern recognition software package were used in performing the classification. Results of the analysis are provided.

NTIS/NASA

LABONTE, A.E., and S.J. McCALLUM, 1977, Image Compression Techniques. Final Technical Report, 30 Jun. 1977 - 30 Jun. 1978, (Contr. No. F30602-76-C-0350; Rept. No. AD-A050 679/OST), 105 pp.
(Control Data Corp., Digital Image Systems Div., Minneapolis, Minn.)

Author Abstract - Timely transmission of large format digital imagery over narrow bandwidth lines requires efficient and high compression of the digitized images. The techniques developed, Micro-Adaptive Picture Sequencing (MAPS), is a two-dimensional, spatial adaptive technique which uses the Redundant Area Coding (REARS) concept along with a versatile algorithm. Compression ratios of 30:1 have been achieved with MSE ranging from .548 to 2.534 percent for a broad variety of visible and radar imagery.

NTIS

L-2

LANDGREBE, D.A., 1976, Computer-Based Remote Sensing Technology -- A Look at the Future, in Remote Sensing of Environment, v. 5, no. 4, 1976, pp. 229-246. (Purdue Univ., Lab. for Applications of Remote Sensing, West Lafayette, Ind.)

Abstract - The purpose of this paper is to provide a broad framework for the anticipation of future developments in the field of remote sensing systems based on machine analysis methods. Based upon both design and operations differences a remote sensing based information system logically is divided into three parts: the scene, the sensor system, and the processing system. The needs and prospects for advancements of each of these are examined. It is pointed out that the scene is the most complex part of the system, and that increased understanding of scene variables is very important to future advancements. The objective of the sensor is to adequately characterize the scene variables in the data. This implies the need for adequate characterization of the spectral, spatial, and temporal variations of the energy emanating from the scene. The potential regarding each of these three types of variations is discussed in turn, as is that for the increased use of ancillary data from other sources. The third portion of the system, the processing system, is discussed in terms of processing algorithms, their implementation, human participation in the processing, and output products. The overall conclusion is that though much has been achieved in the last decade or so, the potential for further development is very great.

GEO-G

LANDGREBE, D.A., 1972, Computer Techniques for Large Scale Remote Sensing Data Processing, in NASA Manned Spacecraft Center, 4th Annual Earth Resources Program Review, v. 2. (Rept. No. NGL-15-005-112), 31 pp. (Purdue Univ., Lab. for Applications of Remote Sensing, Lafayette, Ind.)

Abstract - The development of large scale data processing systems for remote sensing is studied by evaluating (1) the suitability of several sensor types with regard to producing data required for multispectral machine analysis; (2) various types of data preprocessing necessary to prepare such data for analysis; and (3) transfer of machine processing techniques for earth resources data to user community.

NASA

LANDGREBE, D.A., 1973, Crop Identification, Soil Mapping, Water Resources, and Urban Land Use Analysis in Wabash River Basin Based on ERTS-1 Imagery. Bimonthly Progress Report, 1 Jan. - 28 Feb. 1973, (Contr. No. NAS5-21773; Rept. No E73-10364, NASA-CR-131005), 3 pp.
(Purdue Univ., Lab. for Applications of Remote Sensing, Lafayette, Ind.)

Abstract - Preliminary acreage estimates for corn, soybeans, and other cover types made from classification of ERTS-1 data compared well with those made by the U.S. Department of Agriculture. Registration of multiple frames of ERTS-1 CCT data over Lynn County, Texas and Dekalb County, Illinois was achieved to a high degree of accuracy. Spectral/temporal computer pattern recognition analysis was carried out for the first time using satellite data.

NASA/NTIS

LANDGREBE, D.A., 1976, Machine Processing of Remotely Acquired Data, in Remote Sensing of Environment, 1976, (Rept. No. NGL-15-005-112), pp. 249-373. (Purdue University, Lab. for Applications of Remote Sensing, West Lafayette, Ind.)

Abstract - The two major branches of remote sensing are based on image orientation and numerical orientation. Numerically oriented systems tend to involve computers for data analysis. In designing an information-gathering system, the sensor as well as the means of analysis must be well mated to the type of system orientation. Attention is given to sensor types as related to system types, the multispectral approach and pattern recognition, and the multispectral scanner as data source. An illustrative example is given, as well as procedural details in the use of pattern recognition, the speed and cost of data processing, the use of spatial information, and data preprocessing steps.

NASA

L-6

LANDGREBE, D.A., R.M. HOFFER, and F.E. GOODRICK, 1972, Crop Identification, Acreage Estimation, Urban Land Use, Soil Mapping, and Earth Resources Identification in Wabash River Basin Using ERTS-1 Imagery. Bimonthly Progress Report, 1 Sept. - 31 Oct. 1972, (Contr. No. NAS5-21773; Rept. No. E72-10208, NASA-CR-128479, LARS-092972); 29 pp.
(Purdue Univ., Lab. for Application of Remote Sensing, West Lafayette, Ind.)

Abstract - A classification of a portion of frame E-1016-16050 CCT was completed using the LARSYS software. The categories, row crops (corn or soybeans), forest and woodland areas, diverted acres of pastureland or nonproductive grassland areas, water (rivers), clouds, and cloud shadows, were represented by one or more spectral classes. The results of this classification are significant in that they show potential for accurate identification and delineation of forested and agricultural areas using automatic data handling techniques.

NASA/NTIS

LARSON, R.W., et al, 1974, Multispectral Microwave Imaging Radar for Remote Sensing Applications, in Proceedings of the International Union of Radio Science (URSI) Specialist Meeting on Microwave Scattering and Emission From the Earth, Berne, Switzerland, pp. 305-315. (Environmental Research Institute of Michigan, Ann Arbor, Michigan)

Author Abstract - A multispectral airborne microwave radar imaging system, capable of obtaining four images simultaneously, is described. The system has been successfully demonstrated in several experiments and one example of results obtained, fresh water ice, is given. Consideration of the digitization of the imagery is given and an image digitizing system described briefly. Preliminary results of digitization experiments are included.

RADAR BIB

L-8

LATHAM, J.P., 1974, Urban Pattern Recognition and Image Color Discrimination with TV Waveforms and Computerized Matrix Analysis and Mapping. Final Report, 1970 - 1973, (Contr. No. N00014-67-A-0320-0003; Rept. No. AD-778 043), 87 pp.
(Florida Atlantic Univ., Boca Raton, Fla.)

Modified Author Abstract - The report presents concepts, instrumentation techniques, methodology and experimental results of investigations which evaluated feasibility of applying black and white television and waveform signals to the purpose of quantitatively recognizing, discriminating and mapping geographic patterns in imagery or in electronic signals, which transmit these patterns. Colors in aerial photographs, or the environment, are discriminated and identified by combination of relative signal values when filters are used to gather the signal data. Four or fewer filters were required for 96 colors tested. Consequently, phenomena may be identified by color. Recognition of terrain or land use patterns found in an urbanized coastal environment is feasible. The technique is applicable to any pattern at any scale. An annotated bibliography of articles on computerized image processing published in geographic and photogrammetric journals from 1963 to 1973 is also presented.

NTIS/NASA

LEACHTENAUER, J.C., 1975, Optical Power Spectrum Analysis for Land Use Classification, in Proceedings of the Fall Convention, American Society of Photogrammetry, Phoenix, Ariz., Oct. 1975, pp. 466-480.

Abstract - The use of optical power spectrum measurements for land use classification was tested on both small (ERTS-1) and large (1:24,000) scale imagery. Measurements were made using a recording optical power spectrum analyzer (ROSA) manufactured by Recognition Systems Incorporated. This device measures the relative power in each of 32 spatial frequency bands and 32 wedges or angular increments. The ROSA is, in effect, an optical computer, performing two-dimensional Fourier transforms and providing the means to analyze spatial data. Readings were analyzed using a variety of techniques employing multiple spatial properties. Classification accuracies ranged from 75% to 95% depending on image scale, land use class, and the analysis technique employed.

GEO-G

L-10

LEACHTENAUER, J.C., and A.M. WOLL, 1972, Natural Resources Information System, in Proceedings of the American Society of Photogrammetry and American Congress of Surveying and Mapping, Fall Convention, Columbus, Ohio, Oct. 11-14, 1972, pp. 250-269.
(Boeing Co., Civil and Commercial Systems Div., Seattle, Wash.; U.S. Department of the Interior, Minerals and Land Resources Working Group, Washington, D.C.)

Author Abstract - A computer-based natural resources information system was developed for the Bureaus of Indian Affairs and Land Management. The system stores, processes and displays data useful to the land manager in the decision making process. Emphasis is placed on the use of remote sensing as a data source. Data input consists of maps, imagery overlays, and on-site data. Maps and overlays are entered using a digitizer and stored as irregular polygons, lines and points. Processing functions include set intersection, union and difference, and area, length and value computations. Data output consists of computer tabulations and overlays prepared on a drum plotter.

NASA

LEAMER, R.W., C.L. WIEGAND, and D.A. WEBER, 1975, Pattern Recognition of Soils and Crops from Space, in Photogrammetric Engineering and Remote Sensing, v. 41, Apr. 1975, pp. 471-478.
(U.S. Department of Agriculture, Agricultural Research Service, Weslaco, Tex.)

Abstract - An evaluation is conducted of the relative effectiveness of the computer analysis techniques which are commonly employed to extract land use (crop identification) information from digitized aerial photographs. It is found that the minimum distance to the mean (MDM) algorithm and the maximum likelihood ratio (MLR) can both be used for the successful recognition of land-use patterns. The MDM algorithm is slightly more accurate in cases involving the use of three or more variables. The use of the MLR algorithm, however, is preferable in cases in which less than three variables are employed.

NASA/COMP

L-12

LEE, S.H., 1977, Optical Analog and Hybrid Computations, (Contr. No. ENG75-23422 A01; Rept. No. GSE 5627 1). (Univ. of California, Graduate School, Applied Physics and Information Science, San Diego, Calif.)

Abstract - The study of optical computing systems and optical devices to be used in these systems will be continued. First, the investigation of a simplified optical analog computer with optical feedback capable of solving differential equations will be made. The computer will solve various partial differential equations, including partial differential equations with variable coefficients, and nonlinear partial differential equations. To facilitate the solution of nonlinear equations (as well as nonlinear optical processing in general), research will be conducted to improve the sensitivity, resolution and speed of optical devices and materials which have nonlinear transmittance characteristics. Finally, the advanced optical analog computer will be combined with a digital computer to form a hybrid system. The hybrid computer will have the added special feature of a scanned laser beam to write computer-generated complex spatial filters in real-time in the Fourier plane of the optical computer for high-speed solutions to partial differential equations and other information processing applications. In particular, the hybrid system will be used to recognize patterns with statistical properties such as hurricanes in weather satellite photographs and printed letters with different fonts.

SSIE

LEE, Y.J., F. TOWLER, H. BRADATSCH, and S. FINDING, 1977, Computer-Assisted Forest Land Classification by Means of Several Classification Methods on the CCRS IMAGE-100, in 4th Canadian Symposium on Remote Sensing, Quebec, Canada, May 16-18, 1977, pp. 37-46. (Canadian Aeronautics and Space Institute, Ottawa, Canada)

Abstract - This study reported the results of computer-assisted forest land classification by means of principal components colour enhancements, unsupervised and supervised classification and multidate digital analysis on the CCRS IMAGE-100 interactive multispectral analyzer. The study was conducted on three test sites in the interior of British Columbia. Site one was selected for the study of forest land classification; site two for monitoring burned-over areas, and site three for monitoring logged-over areas. The results from principal components colour enhancement were excellent.

GEO-G

LEIB, K.G., R.A. BONDURANT, and S. HSIAO, 1976, Optical Matched Filtering Techniques for Automatic Interrogation of Aerial Reconnaissance Film. Final Report, Sept. 1976, (Contr. No. DAAG53-75-C-0199; Rept. No. RE-524; AD-A030 574), 132 pp.
(Grumman Aerospace Corp., Research Dept., Bethpage, N.Y.)

Abstract - The continuing requirement for aerial reconnaissance imagery has created a need for systems to rapidly screen and interpret this film to complement the human photointerpreters handling the current work load. The Grumman developed Optical Matched Filter Image Correlation System (OMFIC) processes such imagery through holographic lens-matched filter optical memories at high speed conservatively estimated at 180 sq cm per second for 70 mm aerial reconnaissance film. To establish such a system, analyses of matched filter output sensitivities with variation in image parameters are made. The (-3 db) sensitivities determined for the M-60 target are: scale - plus or minus 19 percent in area about 100 percent image; contrast - imagery can have optical density range of 1 to 5 OD; resolution - equal or greater than 5 cycles per target width; and, orientation - plus or minus 8 degrees. These sensitivities were arrived at by independently varying each parameter. Such information is utilized in the memory requirement determination for the target of interest (M-60 tank). The data show the requirement for 23 filter positions of memory to cover a 360 degree area.

DDC

LEIGHTY, R.D., 1972, Analytical Identification of Selected Terrain Features From Multiband Photography. Progress Report, Jul. 72 - Jun 73, (Rept. No. DA0K8045). (Army Engineer Topographic Labs., Research Inst., Ft. Belvoir, Va.)

Abstract - The objective is to study the use of multiband aerial-photography as a means of identifying selected terrain materials. This identification will be accomplished through the use of an automated pattern recognition system. This approach to materials identification will be useful to Department of Defense mappers and users of military intelligence. Separate investigations will be consolidated on solar radiation, atmospheric transmission, terrain reflectance, image quality, etc., for the purpose of establishing a total system which defines the photographic process in terms of system components through which the photographic energy passes. From this, it is planned to analytically formulate an approach to normalizing image transmission densities to obtain quantitative values useful to automated pattern recognition from multiband aerial photographs. Necessary materials were gathered to support the analysis. An analytical study was performed using available textual materials and multiband aerial photography, separating materials into two categories - natural and cultural. It is possible to identify natural materials, such as soils, rocks, vegetation, and water, and cultural materials such as concrete and asphalt. A report is being written. No further work is planned now, but in the future, consideration will be given to a follow-on work unit to conduct field experiments to verify and add credence to the investigation.

HEL-RSG

L-16

LEIGHTY, R.D., 1974, Coherent Optics Potential Applications to Mapping, in American Society of Photogrammetry and Society of Photo-Optical Instrumentation Engineers, Tutorial Seminar on Coherent Optics in Mapping, Rochester, N.Y., Mar. 27-29, 1974. Optical Engineering, Vol. 13, Sept.-Oct. 1974, pp. 440-450. (Army Engineer Topographic Labs., Fort Belvoir, Va.)

Abstract - Some of the roles for the potential application of coherent optical techniques in mapping systems are discussed. Other references on this subject are integrated into the overall framework of coherent optics in mapping processes. Potentials are defined in the eight areas of photogrammetic data reduction, image processing, optical memories, pattern recognition, performance prediction, holographic terrain displays, all-weather mapping, and field applications.

NASA

LEIGHTY, R.D., 1977, Generalized Feature Extraction, (Contr. No. DA0M8064; Rept. No. ZQA138064) (Army Engineer Topographic Labs., Fort Belvoir, Va.)

Abstract - This project will attempt to interface the heterodyned optical correlator (HOC) and the recording optical spectrum analyzer (ROSA) and demonstrate use of three types of image data for pattern recognition. The HOC system will provide a matrix of terrain elevations, and a matrix of high pass digital image while ROSA will yield data from the spatial frequency spectrum. The HOC and ROSA systems will be interfaced. Data will be collected from stereophoto pairs and used to indicate potential feasibility for feature extraction, and pattern recognition software will be prepared.

SSIE

L-18

LEIGHTY, R.D., 1975, Optical Power Spectrum Analysis (OPSA), Report No. 1, Recording Optical Spectrum Analyzer System Hardware, (Rept. No. ETL-TR-74-11, AD-A016 131) 25 pp.
(Army Engineer Topographic Labs., Fort Belvoir, Va.)

Abstract - The optical spectrum analyzer hardware used in pattern recognition research at the Research Institute, US Army Engineer Topographic Laboratories, is discussed in detail. This system involves detection of signals by a segmented spatial frequency plane detector in a coherent optical system when selected portions of an aerial image are illuminated. These signals are then electronically processed and formatted for digital computer processing with pattern recognition software. It is anticipated that the system will lead to applications for automated information extraction from aerial imagery which include cloud screening, extraction of selected planimetric information, image quality analysis, and techniques for automated selection of image preprocessing requirements.

DDC

LEIGHTY, R.D., 1977, Optical Power Spectrum (OPS) Analysis for Pattern Recognition, (Contr. No. DA0N8054; Rept. No. ZQA148054)
(U.S. Army, Coherent Optics Center, Fort Belvoir, Va.)

Abstract - The purpose of this project is to investigate coherent optical techniques for automated interpretation and extraction of cartographic data from aerial photography. The optical power spectrum (OPS) analysis technique is being investigated by using a coherent optical system as an image sampling capability and a software pattern recognition program for classification. OPS data from aerial photographic images containing natural patterns of interest are collected and utilized as training samples for generating classification algorithms for testing. Research is made into the application of spatial arrays to facilitate space and spatial frequency domain data collection and analysis capabilities that will lead to faster, more complete, and more accurate pattern recognition. This report also discusses special purpose OPS systems with potential for near-future operational systems capabilities.

SSIE/HEL-RSG

LESCHACK, L.A., W.R. BRINLEY, Jr., and D.E. McIVOR, 1973, Automatic Processing of Airborne Remote Sensing Data for Pattern Discrimination of Jungle and Other Vegetation Areas, (Contr. No. DAHC04-70-C-0052; Rept. No. D/RT-9; AD 762 583), 41 pp. (Development and Resources Transportation Co., Silver Spring, Md.)

Modified Author Abstract - Aerochrome infrared aerial photography taken over Barro Colorado Island in the Panama Canal Zone is the main source for simulating airborne multi-spectral line-scan data of tropical forest areas. With these new data, the variations of forest canopy spatial statistics as a function of angle of view and angle of sun have been studied. Using 50x50 m. (on the ground) microdensitometer scan ensembles generated from the aerial photography, and frequency distribution and power spectrum analyses of the resulting data, the behavior of a young-mature forest at five different angles of view, and a mature and secondary forest at different times of day were studied. Time and angular variations were applied to various tropical vegetation types seen at Tocache, Peru, and illustrated in a 2x12 matrix form, and a preliminary qualitative as well as quantitative analysis has been presented. The authors conclude that the discussed techniques do have considerable merit for automatic vegetation mapping by airborne means, but that extensive further work would be required to produce the data catalogue and algorithms necessary to develop an on-line, operating system.

DDC/NTIS

LIETZ, J.C., A.J. ZANON, G.T. STEVENS, R.E. BOZEK, and B.K. OPTIZ, 1973, Multispectral Analysis Software. Final Report Jul. 72-Jun. 73, (Contr. No. F30602-72-C-0521; Rept. No. AD-008 196/8ST), 865 pp. (Pattern Analysis and Recognition Corp., Rome, N.Y.)

Modified Author Abstract - The report is prepared as a User's Manual for personnel engaged in the operation of the RADC SCORE (Spectral Combinations for Reconnaissance Exploitation) system. The SCORE program has as its major objective the development and implementation of a multispectral analysis system to identify military targets based on their spectral signature. The specific objective of the subjective contract was the development and implementation of applications software in the form of preprocessing and analysis routines for use in extracting spectral signatures (features) from multispectral data. The spectral features are intended for use on the On-Line Pattern and Recognition System (OLPARS) in the design of enhancement/recognition logic for targets of interest. Parallel to the development of the SCORE program has been the development of the Image Feature Extraction System (IFES). IFES is being implemented as a research tool for use in extracting information from a single image based on the spatial characteristics of targets. SCORE and IFES reside within one software framework in the PDP-11/20/SDS-800 system.

NTIS

L-22

LILLESTRAND, R.L. and R.R. HOYT, 1974, The Design of Advanced Digital Image Processing Systems, in Photogrammetric Engineering, v. 40, Oct. 1974, (Contr. No. F30602-73-C-0024-0141, F30602-73-C-0225), pp. 1201-1218.
(Control Data Corp., Minneapolis, Minn.)

Abstract - The article reviews the nature of digital computers used to process images. Three design-forcing functions discussed include the rate at which digital imagery data flows through the system, the complexity of image transformation, and the nature of output required by the user. Investigations show the ability of digital computers to perform more complex image transformation than is possible with analog methods. Higher speeds and increased spatial and gray-scale quantization consistent with photogrammetric requirements are made possible with improved digital input/output equipment. The largest area of application of the system is in the DOD interest in military surveillance and the NASA-ERTS interest in the remote sensing problem. Tables classifying the functions and the applications of the digital processor are included.

NASA

LINDENLAUB, J., and J. RUSSELL, 1974, An Introduction to Quantitative Remote Sensing, (Contr. No. NAS9-14016; Rept. No. NASA-CR-141860, LARS-NOTE-110474) 63 pp. (Purdue Univ., Lab. for Applications of Remote Sensing, Lafayette, Ind.)

Author Abstract - The quantitative approach to remote sensing is discussed along with the analysis of remote sensing data. Emphasis is placed on the application of pattern recognition in numerically oriented remote sensing systems. A common background and orientation for users of the LARS computer software system is provided.

NTIS/NASA

L-24

LOCKHEED ELECTRONICS CO., 1975, ELLTAB (Elliptical Table) Table Look-Up Algorithm for Pattern Recognition, (Contr. No. MSC-14866), 1 p. (Lockheed Electronics Co., Plainsfield, N.J.)

Abstract - This software package consists of a program which classifies remotely sensed data into categories representing types of vegetation, geological features, or other earth surface aspects of interest. The program applies an advanced table look-up approach to pattern recognition. The essence of the table look-up approach is that at classification time a remotely sensed unit or pixel is assigned to a category by merely looking up its channel readings in a table as opposed to making the lengthy calculations required in a maximum likelihood computation. The table look-up approach makes it possible to process multispectral scanner data using minicomputer (i.e., low cost, small scale, general purpose digital computers). Also, processing time was reduced by a factor of 30 compared with the conventional approach on the same computer. Reproduction quality from ELLTAB is identical to that received from LARSYS. Although the ELLTAB table look-up method requires much less core than previous table look-up methods, it still needs more than the minimum amount required to implement the maximum likelihood decision algorithm. ELLTAB is limited to a maximum of four channels and the current version requires exactly four channels. Also, confidence levels are not available at classification time and consequently cannot be output to the classification tape. The program which was tested on the Univac 1108 and the Varian 620F minicomputer, is written completely in Fortran and operates in batch or demand mode.

NASA

LUCEY, D.J., G.E. FORSEN and M.J.ZORACKI, 1976, Processing of FLIR Data on DICIFER. Final Technical Rept. Jul. 1975-Jun. 1976, (Contr. No. DAAG53-75-C-0277, Rept No. PAR-76-26, AD-A037 136/9ST), 108 pp. (Pattern Analysis and Recognition Corp., Rome, N.Y.)

Author Abstract - This effort has investigated the extent to which automatic tactical target cueing on selected FLIR (forward-looking infrared) imagery can be accomplished using digital image processing and automatic pattern recognition techniques. The DICIFER (Digital Interactive Complex for Image Feature Extraction and Recognition) system was utilized to analyze FLIR image data for the U.S. Army Night Vision Laboratory (NVL). DICIFER is a general purpose R and D tool developed by Pattern Analysis and Recognition (PAR) Corporation for Rome Air Development Center (RADC) Intelligence and Reconnaissance Division (IR). A digital process for automatic detection of tactical targets in FLIR images was designed and tested. The total process included noise removal and contrast enhancement preprocessing; gradient edge detection and boundary chain encoding; and the design of Boolean classification logic. The classification logic was applied against a test set of 34 images. The probability of detection achieved was 88% (38 of 43 targets detected).

NTIS

L-26

LUKES, G.E., 1977, Optical Power Spectrum (OPS) Analysis Related to Change Detection, (Contr. No. DA0M8061; Rept. No. ZQA138061)
(U.S. Army, Coherent Optics Center, Fort Belvoir, Va.)

Abstract - This project plans to research the feasibility of hybrid coherent optical/digital techniques for the detection of significant changes in cartographic information imaged in multidate aerial photography. The optical power spectrum (OPS) analysis technique is being investigated using a coherent optical system utilizing analytical sample positioning procedures and mathematical pattern recognition procedures for decision making. The major objectives are to assemble a set of sequential aerial photographs which document significant cartographic land use changes, and to generate an OPS data base by using the recording optical spectral analyzer (ROSA) to sample specified ground locations imaged in each photo applying analytical sampling procedures developed in FY 75 under 91D/01/0046. The use of mathematical pattern recognition techniques to identify land use changes imaged in multidate aerial photography is also discussed.

SSIE/HEL-RSG

LUKES, G.E., Rapid Screening of Aerial Photography by Optical Power Spectrum (OPS) Analysis, Proceedings of the Society of Photo-Optical Instrumentation Engineers, v. 117, pp. 89 - 97.
(Research Inst., Army Engineer Topographic Labs., Fort Belvoir, Va.)

Abstract - Applications of high-speed optical power spectrum analysis (OPSA) utilizing telecentric scanning systems for the automated analysis of aerial photography for several relatively simple problems are described. Cloud screening is discussed as an example where a statistical pattern recognition approach is successfully applied to optical power spectrum data. Examples of image analysis based on characterization of image structure and orientational content are presented. Projective sampling concepts, which permit image sampling based on ground coordinates in conjunction with a digital data base, are introduced. Finally, use of projective sampling with OPSA is illustrated by an image-to-image cartographic change detection experiment.

NASA

L-28

LUKES, G.E., and L.P. MURPHY, 1978, Automated Feature Extraction Techniques and Strategies Research, (Contr. No. DA0N8004; Rept. No. ZQA148004 1)
(U.S. Army, Coherent Optics Center, Fort Belvoir, Va.)

Abstract - This project will conduct research in automated pattern recognition and analysis strategies leading to the development of techniques and systems for automated feature extraction from aerial imagery for application to automated cartography and MGI. Research will investigate optical, digital, and hybrid automated pattern recognition techniques which lend themselves to incorporation or total replacement of manual or interactive capabilities for the recognition of natural and cultural features from aerial imagery. Techniques will be developed for characterization of aerial imagery and data from terrain data bases. Particular attention will be given to those algorithms and strategies for definition of concepts of automated feature extraction systems of the future. Techniques will attempt to integrate data from different data domains, i.e., space domain, sensor domain, spatial frequency domain, terrain elevations, data base information, etc. Analysis strategies will define the sequential decision processes associated with recognition and delineation.

SSIE

MCEWEN, R.B., 1971, Photogrammetric Evaluation for Use of RBV Images from ERTS, in Proceedings of American Society of Photogrammetry, Symposium on Computational Photogrammetry, San Francisco, Calif., September 7-11, 1971, pp. 70-82.
(U.S. Geological Survey, McLean, Va.)

Abstract - A description is presented of photogrammetric and cartographic evaluations of the return-beam vidicon (RBV) television system and the multispectral scanner (MSS) on board the ERTS satellite. The images telemetered from these two imaging sensors will be converted to film and will constitute the basic data for most ERTS experiments and earth resources investigations. The overall system requires geometric and radiometric calibration, specialized image processing, and ground control points for cartographic reference. Development of calibration data for the RBV is discussed, together with research on the geometrical distortions of high-resolution television systems.

NASA

MCHUGH, A.P. and J.E. HOWRY, 1973, TAC Participation in MARRES DT and E. Final Report - 2 Oct.-8 Dec. 72, (Contr. No. TAC-72F-134), 82 pp. (Tactical Air Warfare Center, Elgin AFB, Fla.)

No Abstract Available

DDC

MCMURTRY, G.J., G.W. PETERSEN, and F.Y. BORDEN, 1976, Interdisciplinary Analysis and Interpretations of LANDSAT Data, in International Earth Resources Management Symposium, Houston, Tex., Jan. 27-29, 1976, pp. 325-332.

Abstract - Specific results include a study in land cover, discrimination between types of forest resources and vegetation, detection of previously unknown geologic faults and correlation of these with known mineral deposits and ground water, mapping of mine spoils in the anthracite region of eastern Pennsylvania, mapping of strip mines and acid mine drainage in central Pennsylvania, agricultural land cover mapping, floodplain mapping, and detection of gypsy moth infestation. Both manual photointerpretive techniques and automatic computer processing methods have been developed and used, separately and in a combined approach.

GEO-G

MCNEE, F.J., 1973, Computerized Simulation of Optical Pattern Recognition and Image Processing System. M.S. Thesis, (Contr. No. DAAB07-72-C-0259; Rept. No. AD-761882, R-606, UILU-ENG-73-2208), 67 pp. (Illinois Univ., Coordinated Science Lab., Urbana, Ill.)

Author Abstract - The promise of obtaining a high speed pattern recognition system has been the stimulus for a great deal of work with coherent optics. The results, however, seem to lack the flexibility required of a functional system. An approach is proposed here which addresses itself to this need. It contains both optical and digital features, in particular the use of filtering and the use of syntactic pattern description in place of templates or curve tracing. Developed in Chapter 2 is the background material for this topic. In Chapter 3, the pattern recognition problem is posed, difficulties associated with the problem are discussed and a solution is offered. The results of simulation, the test of the proposed approach, are analyzed in Chapter 4. Chapter 5 summarizes the conclusions drawn from this work.

DDC

MALILA, W.A., R.F. NALEPKA, and J.E. SARNO, 1975, Image Enhancement and Advanced Information Extraction Techniques for ERTS-1 Data. Final Report, 12 Jun. 1972 - 31 Oct. 1974, (Contr. No. NAS5-21783; Rept. No. E75-10337, NASA-CR-143074, ERIM-193300-66-F), 141 pp.
(Environmental Research Inst. of Michigan, Infrared and Optics Div., Ann Arbor, Mich.)

Abstract - It was demonstrated and concluded that (1) the atmosphere has significant effects on ERTS MSS data which can seriously degrade recognition performance; (2) the application of selected signature extension techniques serve to reduce the deleterious effects of both the atmosphere and changing ground conditions on recognition performance; and (3) a proportion estimation algorithm for overcoming problems in acreage estimation accuracy resulting from the coarse spatial resolution of the ERTS MSS, was able to significantly improve acreage estimation accuracy over that achievable by conventional techniques, especially for high contrast targets such as lakes and ponds.

NASA

MARK, J.W., 1976, Computer Analysis of Photo Pattern Elements, in Photogrammetric Engineering and Remote Sensing, v. 42, Apr. 1976, pp. 545-550.
(USAF, Offutt AFB, Neb.)

Author Abstract - Much success has been achieved in collection techniques for remote sensing data, yet more investigation remains to be done in processing techniques. This paper describes an attempt to adopt the classical photo pattern element techniques to computer processing. Two approaches were tried: the first had limited success but the second was successful. Interpretation time was reduced, as was the skill level required of the interpreter, and the photo pattern element concept was shown to be highly flexible and adaptable to computer processing.

NASA

MARTIN, W.N., and J.K. AGGARWAL, 1977, Dynamic Scene Analysis: The Study of Moving Images, (Contr. No. F44620-76-C-0089; Rept. No. TR-184) 88 pp. (Texas Univ. at Austin, Electronics Research Center, Austin, Tex.)

Abstract - Scene analysis has long been a fusion point between the fields of pattern recognition and artificial intelligence: it integrates techniques from both disciplines. Usually, these techniques are applied to single frames containing static images, but recently there has been growing interest in developing techniques which could be applied to scenes containing moving images. This report contains two major parts: the first part is a survey of the computer systems, as reported in the literature, which attempt to analyze scenes containing moving images; the second part is a detailed description of a system to analyze scenes containing moving planar curvilinear objects.

NTIS

MEAD, R.A., and M.P. MEYER, 1977, LANDSAT Digital Data Application to Forest Vegetation and Land Use Classification in Minnesota, in Proceedings of 4th Annual Symposium on Machine Processing of Remotely Sensed Data, West Lafayette, Ind., Jun. 21-23, 1977, (Contr. No. NAS5-20985), pp. 270-280.
(University of Minnesota, St. Paul, Minn.)

Author Abstract - LANDSAT digital data were used to map eleven categories of land cover in north central Minnesota. The classification accuracy of these maps was found to be very low and they were not adequate for use by field level resource managers. A discussion of the advantages and disadvantages of various processing systems, different algorithms, and the problems in selecting training sets, is included.

NASA

MILGRAM, D.L., 1975, Computer Methods for Creating Photomosaics, in IEEE Transactions on Computers, v. C-24, Nov. 1975, (Contr. No. F44620-72-C-0062), pp. 1113-1119.
(Maryland University, College Park and Baltimore, Md.)

Author Abstract - A technique is described which allows overlapping images to be combined into a photomosaic in which the visual impact of the introduced seam has been minimized. Images which have been brought into geometric and gray scale register are combined on a line-by-line basis by choosing a 'best' seam point for each line. The resulting artificial edge at the seam point is then locally smoothed.

NASA

M-6

MILLER, S.H., and K. WATSON, 1977, Evaluation of Algorithms for Geological Thermal-Inertia Mapping, in Proceedings of the 11th International Symposium on Remote Sensing of the Environment, University of Michigan, Ann Arbor, Mich., Apr. 25-29, 1977, pp. 1147-1160.
(U.S. Geological Survey, Denver, Colo.)

Abstract - The errors incurred in producing a thermal-inertia map are of three general types: measurement, analysis, and model simplification. To emphasize the geophysical relevance of these errors, the paper expresses them in terms of uncertainty in thermal inertia and compares these uncertainties with the thermal-inertia values of geologic materials. Three surface temperature algorithms were evaluated: linear Fourier series, finite difference, and LaPlace transform. Model simplification errors result from three sources: transient effects, topography, and surface coating effects. The total system errors in thermal inertia are placed in geologic context by noting the separation in thermal-inertia values for various geologic materials.

EIX

MITCHEL, R.H., 1970, Report on Project MICHIGAN, Subproject 3: Image Interpretation and Sensor-Output Processing. Final Report, (Contr. No. DA-28-043-AMC-00013(E); Rept. No. 6400-208-T, AD-510 351) 77 pp. (Michigan Univ., Inst. of Science and Technology, Ann Arbor, Mich.)

Author Abstract - This report describes the work carried out to assess the possibility of automatically detecting targets of military interest by means of optical spatial filtering. A mathematical description of the matched filtering detection process and of the implementation of an optical system to perform this operation are included. The results of a study to evaluate the performance of the optical spatial filtering technique are discussed along with the experiments performed. Target detection statistics and major causes of false alarms have been compiled.

DDC

MOORE, R.K., 1970, Remote Sensing at the University of Kansas in Radar Systems, Third Annual Earth Resources Program Review, Agriculture, Forestry and Sensor Studies, v.2., pp. 41-1-41-39.
(Kansas Univ. Center for Research, Inc., Lawrence, Kans.)

Author Abstract - Remote sensing research at the University of Kansas is a multidisciplinary effort involving the interaction of radar engineers, data processing engineers, and geoscientists who approach remote sensing as a systems problem. The interfaces between target-sensor interaction, sensor research, data processing, and geoscience user interpretation can best be solved by such a team effort. Target-sensor interaction determines the way in which the sensor views the object and consequently the way in which the interpreter can use the sensor for studying the object. Sensor development is another activity in the system. When the sensor produces images in multiple wavelengths or polarizations, or even at a single wavelength and polarization at multiple times, the images must be brought to congruence before they can be automatically processed with pattern recognition techniques. Multiple images almost demand automatic processing because of the difficulty for the human interpreter to relate one image to the other. Digital processing techniques should be used to establish appropriate algorithms for particular data sets but analog processing techniques should be then applied to the large mass of data. The data are useless to the interpreter unless displayed in an easily understood fashion; thus displays are an important part of the remote sensing system. Interpretation at any time after generation of the display requires the use of recorders, varying from a simple camera to an elaborate magnetic recording system. Automatic processing of data requires calibration throughout the system. Interpreters should contribute significantly to the development and adjustment of the sensors, congruencers, processors, and displays since they are the ultimate users.

RADAR BIB

MOR, M., and T. LAMDAN, 1972, A New Approach to Automatic Scanning of Contour Maps, in ACM Communications, v. 15, Sept. 1972, pp. 809-812.
(Ministry of Defence, Tel Aviv, Israel; Weizmann Institute of Science, Rehovot, Israel)

Abstract - The problem of automatic digitizing of contour maps is discussed. The structure of a general contour map is analyzed, and its topological properties are utilized in developing a new scanning algorithm. The problem of detection and recognition of contour lines is solved by a two color labeling method. It is shown that for maps containing normal contour lines only, it suffices to distinguish between so-called even and odd lines. The tangency problem involved in practical scanning is discussed, and a solution based on minimizing computer memory space and simplifying control program is suggested.

NASA

M-10

MORITZ, S.H. and C.B. SHELTON, 1976, Reference Scene Software (RSS): User's Manual and Program Maintenance Manual. Contract Report. 2 Volumes, (User's Manual Rept. No. PRC-R-1938, 77 pp.; Program Maintenance Manual Rept. No. PRC-R-1939, 169 pp.)
(PRC Information Sciences Co., McLean, Va.)

Abstract - RSS is a set of eleven CDC 6400 computer programs used in-house at USAETL, Ft. Belvoir, Virginia, to produce simulated Plan Position Indicator (PPI) radar scenes. The two inputs required by RSS are a matrix array (raster format) of digital terrain elevations and a corresponding vector digitized list of planimetry features (roads, lakes, railroads, cities, rivers, etc.). The output of RSS is a raster format magnetic tape image of the circular PPI scene, which is later formatted on to 35 mm film and machine compared in the actual scene of the area to determine the 'goodness' of correlation.

GEO-G

MOWER, R.D., 1974, Selecting Appropriate Airborne Imagery for the Discrimination of Land and Water Resources, in Conference on Earth Resources, Observation and Information Analysis Systems: Remote Sensing of Earth Resources, v.3, Tullahoma, Tenn., Mar. 25-27, 1974, pp. 545-559.
(Univ. of Kansas, Lawrence, Kans.)

Abstract - Results are given of a series of tests which were designed to evaluate the use of multispectral imagery for the discrimination of selected water and land resource categories. A semi-automated image interpretation technique, employing a simple Bayes decision rule, was used to classify image density values representing each of the resource categories and subcategories. Fifty-nine tests were conducted for ten different channels and/or combinations of multispectral channels with the following results. First, as discrete data were added to decision matrices better results were achieved. Secondly, multiband channels scored higher for most of the resource categories than did their multiemulsion counterparts.

COMP

M-12

MOWER, R.D., and M.L. HEINRICH, 1977, A Computer Processed/ LANDSAT/Land Cover Map of North Dakota, in Remote Sensing of Earth Resources, v. 6 - 6th Annual Remote Sensing of Earth Resources Conference, Tullahoma, Tenn., March 29-31, 1977, pp. 295-307. (University of North Dakota Institute for Remote Sensing, Grand Forks, N. Dak.; Bendix Corp., Aerospace Systems Div.)

Abstract - A land cover map was produced at a scale of 1:500,000 for the state of North Dakota. The map was produced from LANDSAT digital data processed by a Bendix multispectral data analysis system (MDAS). Each pixel (1.12 acres) is classified and portrayed in colors representing either one of ten selected land cover categories or an uncategorized class. The ten land cover categories are as follows: (1) built-up, (2) cropland, (3) fallow, (4) exposed subsoil or saline seep, (5) rangeland, (6) rangeland, pasture, and agricultural (mixed), (7) forest, (8) water, (9) wetland, and (10) barren.

NASA

MUCCIARDI, A.N., 1973, The Mucciardi-Gose Clustering Algorithm and Its Applications in Automatic Pattern Recognition. Final Report. 15 Mar. - 15 Nov. 1972, (Contr. No. F33615-72-C-1491; Rept. No. 662-FTR; AD-767 273/6), 75 pp.
(Adaptronics, Inc., McLean, Va.)

Author Abstract - A procedure known as the Mucciardi-Gose clustering algorithm, CLUSTR, for determining the geometrical or statistical relationships among groups of N-dimensional vectors is presented. The vectors may be thought of as samples from some complex process that is under study. For example, the process may be aerial reconnaissance photography, and the vectors may be digital representations of the pictures. In this example, the geometrical or statistical relationships between the pictures, some part of the pictures, or some derivative of the pictures, must be known before an automatic analysis of the content of the pictures can be performed by machine. The CLUSTR algorithm provides a means of determining these relationships. A general discussion of clustering algorithms is given; the particular advantages of the Mucciardi-Gose procedure are described. The mathematical basis for, and the program structure of, the CLUSTR algorithm are presented in detail. Topics covered include: initial cluster hypervolume estimates, birth and growth rate processes of clusters, estimation of cluster hypervolume overlap. Specific instructions for use of the programs and for interpretation of the results are provided.

NTIS

M-14

MURPHREY, S.W., R.C. DEPEW, and R. BERNSTEIN, 1977, Digital Processing of Conical Scanner Data, in Photogrammetric Engineering and Remote Sensing, v. 43, Feb. 1977, pp. 155-165, 167.
(IBM Corp., Gaithersburg, Md.)

Author Abstract - An experimental software system to remove systematic errors and to geometrically correct S-192 conical scanner data by using digital techniques has been developed. The digital image processing programs were implemented on an IBM 370/168 computer and were used on a September 15, 1973 S-192 image of Lake Havasu, Arizona. The resulting digital image was recorded on film and was of good quality. The experiment described demonstrates that digital image processing techniques can be used to correct conical scanner data.

NASA

MURPHY, L.P., 1970, Digital Image Processing for Terrain Pattern Recognition, in Proceedings of the American Society of Photogrammetry and American Congress on Surveying and Mapping Technical Conference, Denver, Colo., Oct. 7-10, 1970, pp. 324-354. (Army Engineer Topographic Labs., Fort Belvoir, Va.)

Author Abstract - The U.S. Army Engineer Topographic Laboratories have evaluated and tested a prototype digital image processing system for performing pattern recognition experiments. Tests and procedures are described for evaluating the Natural Image Computer (NIC) with its systems software, in addition to the conclusions reached from the analysis. The prototype system was designed as an exploratory laboratory device for pattern recognition studies and limited feature delineation capability using vertical aerial photography as an input. The structure of the recognition algorithms is based upon recognition and correlation to basic feature shapes and statistical characteristics of the grey scale distribution of Military Geographic Intelligence. The NIC is a versatile laboratory device capable of accepting cut film photographs and producing grey scale digitization of the imagery at 16, 32, and 64 grey scale levels.

NASA

M-16

MURPHY, L.P., and W.W. ABBE, 1975, An Automated Technique for Measuring Built-up Urban Areas from Map Graphics Through Analog Image Processing. Research Note, Dec. 1974-Jan. 1975, (Contr. No. DA PROJ. 4A7-62707-A-854; Rept. No. AD-A011446, ETL-0012), 23 pp.
(Army Engineer Topographic Labs., Fort Belvoir, Va.)

Abstract - This research report describes a production application using experimental analog (video) image processing equipment for measuring areas (kilometers squared) depicted on graphic map input as built-up urban areas. The note concludes that state-of-the-art analog image processing components can be configured and used to measure built-up areas in one-twelfth of the time required by conventional manual means.

NTIS

MYERS, V.I., M.J. RUSSELL, D.G. MOORE, and G.D. NELSON, 1975, Boundary Detection Algorithm for Locating Edges in Digital Imagery, (Rept. No. 74-10), 32 pp. (South Dakota State Univ., Remote Sensing Inst., Brookings, S. Dak.)

Abstract - Initial development of a computer program which implements a boundary detection algorithm to detect edges in digital images is described. An evaluation of the boundary detection algorithm was conducted to locate boundaries of lakes from LANDSAT 1 imagery. The accuracy of the boundary detection algorithm was determined by comparing the area within boundaries of lakes located using digitized LANDSAT imagery with the area of the same lakes planimetered from imagery collected from an aircraft platform.

NASA/GEO-G

N-1

NASU, M. and J.M. ANDERSON, 1976, A Multiseries Digital Mapping System for Positioning MSS and Photographic Remotely Sensed Data, in International Society for Photogrammetry, 13th International Congress for Photogrammetry, Helsinki, Finland, Jul. 11-23, 1976, 31 pp.
(University of California, Berkeley, Calif.)

Abstract - The multiseries remote sensing - which consists of multispectral, multiband, multistage, multidate remote sensing data - provides various kinds of spectral or radiometric information in different kinds of recording and image characteristics. Results are presented for a study designed to develop and investigate the feasibility of a method for positioning multiseries remotely sensed data by means of geometric multistage sampling. The designed multiseries positioning system consists of point identification and measurement of images, geometric adjustment for determination of exterior orientation of data, and analytical image restitution. The key concept in this procedure is the capability of performing sequential or simultaneous adjustments with all photographic and scan data while using parametric constraints for specified orientation parameters. It is shown that positioning of multiseries data is feasible and yields improved results using sequential or simultaneous parametric adjustment of multistage imagery.

NASA

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, 1978,
Image Processing Facility Performance Evaluation and Improvement, (Contr. No. 310-40-39; Rept. No. ZH 4084 6)
(National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.)

Abstract - This RTOP supports the development of digital image processing techniques for sensors such as Multispectral Scanner (MSS) and Thematic Mapper (TM), system performance evaluation methods, and an archival data storage system. In the area of image processing techniques, very accurate radiometric interpolation methods (e.g., 6 x 6 cubic function) are investigated as to their attendant degradation and impact on system throughput. In addition, Ground Control Point (GCP) identification and registration methods are evaluated, or developed for the purpose of achieving a geodetic registration accuracy of less than 30 meters. Implementation feasibility of system performance measurement methods (e.g., modulation transfer function) on the previously developed Image Display and Recording System (IDARS) is studied in terms of software and hardware resource requirements. Promising high density laser-disc recording systems which can store 10 to the 14th power - 10 to the 15th power bits of data are to be studied with respect to operational environment, online operation with image processing systems, and implementation cost. These will be systems which were previously surveyed as to their potential applicability and technological feasibility.

SSIE

N-3

NEZ, G. and D.L. MUTTER, 1977, A Regional Land Use Survey Based on Remote Sensing and Other Data - A Report of a LANDSAT and Computer Mapping Project, 3 volumes, (Contr. No. NAS5-22338), 117 pp. (Federation of Rocky Mountain States, Inc., Denver, Colo.; National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.)

Abstract - The project mapped land use/cover classifications from LANDSAT computer compatible tape data and combined those results with other multisource data via computer mapping/compositing techniques to analyze various land use planning/natural resource management problems. Data were analyzed on 1:24,000 scale maps at 1.1 acre resolution. LANDSAT analysis software and linkages with other computer mapping software were developed. Significant results were also achieved in training, communication, and identification of needs for developing the LANDSAT/computer mapping technologies into operational tools for use by decision makers. Portions of this document are not fully legible.

NASA

NG, K.Y.K, 1977, An Automatic Image Registration and Overlay System--For LANDSAT Remotely Sensed Data Analysis, in Computers and Electrical Engineering, v. 4, Mar. 1977, pp. 71-85.
(Operational Research and Analysis Establishment, Ottawa, Canada)

Author Abstract - In this paper we present an automatic algorithm for registering and overlaying imagery. The algorithm basically attempts to find by successive approximations the best affine transformation or second order polynomial relating to the two images. The method requires the specification of only a matching pair of control points, then new control points are found approximately by extrapolating the old affine transformation to larger areas and then using correlation to find the best match. Thus an obvious advantage of this algorithm lies in its automatic feature in locating and matching more potential ground control points. This paper also discusses the effect of the distribution of control points on the affine transformation. Finally, the method is tested on LANDSAT data and the results are discussed.

NASA

N-5

NICHOLS, D.A., J.P. DANGERMOND, and R. POSTMA, 1972, Using Grid Cell Digital System to Integrate Data from High Altitude Aerial Photographs with Other Sources of Information, (Contr. No. N00014-69-A-0200-5001; Rept. No. AD-731703, TR-T-71-4), 41 pp. (Environmental Systems Res. Inst., Redlands, Calif.)

Author Abstract - The paper demonstrates the use of a grid cell digital system to integrate data derived from high altitude aerial photographs with other sources of information (e.g., topography, road maps, geology, etc.). The system has the capabilities of data storage, retrieval, and manipulation. A data bank file possessing spatial characteristics can be displayed with computer graphics, and manipulated in the computer. The demonstration involves the application for a regional park location model.

NASA/NTIS

NICHOLS, J.D. and W.M. SENKUS, 1975, Combined Sequential Analysis of Multiple Features -- For Multispectral Data Classification, in Proceedings of the 2nd Symposium on Machine Processing of Remotely Sensed Data, West Lafayette, Ind., Jun. 3-5, 1975, pp. 1A-28 to 1A-30.
(University of California, Berkeley, Calif.)

Abstract - A method for the computerized sequential analysis of multiple-feature remote sensing data is described. The method called 'ownmask' utilizes previous classification results to control new classifications. The preparatory data consists of a previous classification (masked or unmasked), multifeature digital data which must overlay the result of the previous classifications (the mask), and one or more sets of training statistics describing all the new classes to be found in the data. The method is applied to analysis of juniper wood inventory data sensed by the LANDSAT-1 multispectral band scanner.

NASA

N-7

NISENSON, P., J. FEINLEIB, R.A. SPRAGUE, and S. IWASA, 1974, Characterization and Optimization of an Electro-Optic Imaging Device for Real-Time Map Profiling, (Contr. No. DAAK02-74-C-0029; Rept. No. AD/A-005 561), 53 pp. (ITEK Corp., Optical Systems Div., Lexington, Mass.; Army Engineer Topographic Labs, Fort Belvoir, Va.)

Abstract - The operation of an electro-optic image modulator and storage device for use in real-time optical processing systems is described. Major emphasis was placed on optimizing the device performance by proper selection of design and operating parameters. The pockels read-out optical modulator (PROM) is used to provide temporary storage of an image that can be read into the PROM either sequentially from a laser or CRT scanner or in parallel from a transparency. The PROM is constructed from a thin slice of bismuth silicon oxide, a cubic crystal exhibiting the pockels effect, photoconductivity when illuminated with blue light, and resistivity sufficient to allow up to 2 hours of charge storage. The crystal slice is oriented normal to 100, polished flat, and coated with an insulating layer of parylene. A dichroic layer, reflecting red light but transmitting blue, is sometimes deposited on one side of the crystal before it is coated with parylene. In the operation of the device, an electrical field is first stored in the interfaces. The stored image can then be read out by incoherent light or by a laser for coherent optical processing.

NTIS

NUNEZ DE LAS CIEVAS, 1976, Thematic Mapping, Land Use, Geological Structure and Water Resources in Central Spain, (Contr. No. 28760), 341 pp. (Instituto Geografico y Gatastral, Madrid, Spain)

Abstract - The images can be positioned in an absolute reference system (geographic coordinates or polar stereographic coordinates) by means of their marginal indicators. By digital analysis of LANDSAT data and geometric positioning of pixels in UTM projection, accuracy was achieved for corrected MSS information which could be used for updating maps at scale 1:200,000 or smaller. Results show that adjustment of the UTM grid was better obtained by a first order, or even second order, algorithm of geometric correction. Digital analysis of LANDSAT data from the Madrid area showed that this line of study was promising for automatic classification of data applied to thematic cartography and soils identification.

GEO-G/NASA

O-1

OCHIAI, H., S. TAKEUCHI, and K. OHI, 1978, Digital Analysis of LANDSAT Images and Applications, in Fujitsu Scientific and Technical Journal, v. 14, Mar. 1978, pp. 1-18.
(Toba Merchant Marine College, Toba, Japan; Fujitsu Laboratories, Ltd., Kawasaki, Japan)

Abstract - Digital image analysis techniques for remote sensing applications are discussed. New techniques for image enhancement in false color display and for thematic analysis are outlined along with some illustrative examples using actual LANDSAT imagery. The false color display allows images to be readily interpreted by enhancing their spectral characteristics through digital processing, while the thematic analysis adopts simple techniques without limiting the statistical distribution form of the data. The discussed thematic analysis techniques include classification per pixel, classification per area, and similarity analysis. The effectiveness of the thematic analysis is demonstrated by applying it to the extraction of yearly variation in land use and to the survey of ocean environment.

NASA

ODENYO, V.A.O., and D.E. PETTRY, 1977, Land-Use Mapping by Machine Processing of LANDSAT-1 Data, in Photogrammetric Engineering and Remote Sensing, v. 43, No. 4, Apr. 1977, pp. 515-524.
(Virginia Polytechnic Institute and State University, Blacksburg, Va.)

Abstract - The paper discusses machine-processed land-use map generation of a portion of the city of Virginia Beach, Virginia, by means of the LARSYS software system applied to LANDSAT-1 MSS remote sensing data. The objectives were to test the applicability of the cited rapidly changing and complex environment and to determine the feasibility of producing an operational land-use map by using the machine analysis approach. Six tentative land-use test classes are selected: urban, agricultural, wooded, water, wetland, and bare land. The LARSYS software system is shown to be applicable in areas with complex land uses. The machine analysis approach reduces bias in classification, and the inherent digitizing of the data facilitates data storage and various forms of retrieval. Comparison with the USGS's proposed land-use classification system is included.

NASA

O-3

O'HANDLEY, D.A., 1972, Recent Developments in Digital Image Processing at the Image Processing Laboratory of Jet Propulsion Laboratory, in Remotely Manned Systems: Exploration and Operation in Space; Proceedings of the First National Conference, Pasadena, Calif., September 13-15, 1972, (Contr. No. NAS7-100, NIH-RR-00443, PHS-HL-14138-01), 12 pp.
(California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.)

Abstract - Some of the recently developed computer-aided digital image processing techniques are reviewed. Special attention is given to mapping and mosaicking techniques and to preliminary developments in range determination from stereo image pairs. The discussed image processing utilization areas include space, biomedical, and robotic applications.

NASA

PALMER, R., 1977, A Computer Method for Transcribing Information Graphically from Oblique Aerial Photographs to Maps, in Journal of Archeological Science, v. 4, no. 3, 1977, pp. 283-290.

Author Abstract - A method is outlined whereby the information on oblique aerial photographs is transcribed graphically in plan form by the use of a simple computer program. Use of the method demands access to a computer providing graphically plotted output and to a digitizing table to produce a suitable form of input. The basis of the program is a set of equations for projectivity between planes. Thus the method has some inherent inaccuracy, although within generally acceptable limits, and is best suited to lowland areas. The present use of the method is described and certain suggestions towards a standardized presentation of aerial photograph transcriptions are included.

GEO-G

PANTON, D.J., 1978, A Flexible Approach to Digital Stereo Mapping, in Photogrammetric Engineering and Remote Sensing, v. 44, no. 12, Dec. 1978, pp. 1499-1512. (Control Data Corp., Minneapolis, Minn.)

Abstract - A flexible algorithm has been developed to meet the changing requirements for generating terrain data from digital stereo sensor records. The algorithm includes an image matching procedure in which parallax components are determined by automatically correlating corresponding image features. The algorithm is adaptive and can handle various types of sensor and natural terrain conditions. Reliability monitoring of the output terrain data is performed on the basis of the in-process analysis of local image areas. The reliability measure dictates various strategies that the algorithm can apply in image areas where automatic correlation is difficult. The algorithm was implemented on a distributive network of parallel digital processors. In this system, production speed is attained because of the inherent parallelism of the modular processors. Flexibility is maintained because the processors are microprogrammable. In this way, new sensor imaging characteristics and new algorithm strategies can be incorporated without disturbing the fundamental software and hardware structure of the system. Production times for compiling a representative stereo model on this parallel configuration far exceed the capability of general-purpose computers.

Handsearch

PANTON, D.J., 1977, Digital Cartographic Study and Benchmark, 4th Interim Report, (Contr. No. DAAG53-75-C-0195; Rept. No. AD-A043 156/9SL), 73 pp. (Control Data Corp., Digital Image Systems Div., Minneapolis, Minn.)

Author Abstract - The results of Phase D are reported in the development and implementation of a stereo matching algorithm that can be used in automatic terrain data collection. The primary purpose of this phase was to generalize the algorithm that was developed under phases A, B, and C to handle more uncontrolled cases of central perspective photography and to lay the groundwork for handling non-central perspective photography. Previous developments and algorithm logic modifications have been reported in a rather piecemeal fashion over the first three phases. This report combines all these developments into a consistent description of the matching algorithm as it appears to date, including the modifications of Phase D.

DDC

PARK, K.Y., and L.D. MILLER, 1978, Korean Coastal Water Depth/ Sediment and Land Cover Mapping (1:25,000) by Computer Analysis of LANDSAT Imagery, (Rept. No. NASA-TM-79546), 23 pp.
(Colorado State Univ., Fort Collins, Colo.; National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.)

Abstract - Computer analysis was applied in single date LANDSAT MSS imagery of a sample coastal area near Seoul, Korea equivalent to a 1:50,000 topographic map. Supervised image processing yielded a test classification map from this sample image containing 12 classes: 5 water depth/sediment classes, 2 shoreline/tidal classes, and 5 coastal land cover classes at a scale of 1:25,000 and with a training set accuracy of 76%. Unsupervised image classification was applied to a subportion of the site analyzed and produced classification maps comparable in results in a spatial sense. The results of this test indicated that it is feasible to produce such quantitative maps for detailed study of dynamic coastal processes given a LANDSAT image data base at sufficiently frequent time intervals.

NASA/NTIS

PEET, F.G. and J.M. WIGHTMAN, 1978, A Poor Man's Digital Image Interpretation System, in Canadian Journal of Remote Sensing, v. 4, no. 1, pp. 29-31.

Author Abstract - This report summarizes the approach taken by the Forest Management Institute to develop a basic, comparatively inexpensive digital image interpretation system for remotely sensed data, based on a minicomputer. The report should be of interest to those contemplating the purchase of a digital image interpretation system who are constrained by cost and other resources.

GEO-G

P-6

PENTLAND, A.P., 1975, The Use of Unsupervised Clustering as a Classifier for LACIE MSS Data, (Contr. No. NAS9-14123; Rept. No. ERIM-109600-39-R), 14 pp. (Environmental Research Inst. of Michigan, Ann Arbor, Mich.; NASA Earth Resources Survey Program, Washington, D.C.; National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, Tex.)

Abstract - This classification method appears to give accurate field center results and to give practical, statistically consistent and accurate estimates of crop proportions. The accuracy of this method is attributable to certain qualities of the particular clustering algorithm. These qualities are freedom from assumptions about Gaussian data, and the continual updating of distribution estimates, including updating the number of modes. This method is relatively tolerant of errors in the determination of crop type, as crop identity is used only for identifying clusters, and not for computing signatures.

NTIS

PODWYSOCKI, M.H., J.G. MOIK, and W.C. SHOUP, 1975, Quantification of Geologic Lineaments by Manual and Machine Processing Techniques--LANDSAT Satellites-Mapping/ Geological Faults, in NASA Earth Resources Symposium, Houston, Texas, June 1975, (Rept. No. NASA-TM-X-70951, X-923-75-183), 28 pp.
(Computer Sciences Corp., Silver Spring, Md.)

Author Abstract - The effect of operator variability and subjectivity in lineament mapping and methods to minimize or eliminate these problems by use of several machine preprocessing methods was studied. Mapped lineaments of a test landmass were used and the results were compared statistically. The total number of fractures mapped by the operators and their average lengths varied considerably, although comparison of lineament directions revealed some consensus. A summary map (785 linears) produced by overlaying the maps generated by the four operators shows that only 0.4 percent were recognized by all four operators, 4.7 percent by three, 17.8 percent by two, and 77 percent by one operator. Similar results were obtained in comparing these results with another independent group. This large amount of variability suggests a need for the standardization of mapping techniques, which might be accomplished by a machine aided procedure. Two methods of machine aided mapping were tested, both simulating directional filters.

NASA

P-8

POTTER, A.E., JR., 1972, Computerized Optical System for Producing Multiple Images of a Scene Simultaneously. (Rept. No. NASA-CASE-MSC-12404-1), 4 pp. (National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, Tex.)

Abstract - A system is disclcsed for producing multiple images of a scene where the image is viewed from a single optical system and converted to separate displays at different light wavelengths. All the images are produced simultaneously. The embodiment includes a Michelson interferometer which transmits the light intensity to a mosaic of independent light detectors. The detectors are independently coupled to an analog to digital converter which digitizes the electrical response of the detectors. The signals from the unit are stored in a memory unit and selected by a scanner unit as a function of wavelength and the increment of the detector mosaic and applied to a display device. By virtue of the wavelength selection, different display devices are operated at different wavelengths to display the image at the selected wavelength.

NASA

PRAGER, J.M., 1978, Extracting and Labelling Boundary Segments in Natural Scenes (Revised and Updated). Interim Rept. Sep. 78. (Contr. No. N00014-75-C-0459, PHS-NS-09755; Rept. No. COINS-TR-78-17, AD-A060 042), 47 pp.
(Dept. of Computer and Information Science, Univ. of Massachusetts, Amherst, Mass.)

Abstract - This paper describes a set of algorithms used to perform segmentation of natural scenes through boundary analysis. The techniques include preprocessing, differentiation using a very simple operator, relaxation using case analysis, and postprocessing. The system extracts line segments as connected sets of edges, labels them, and computes features for them such as length and confidence.

DDC

P-10

PRESTON, K., JR., 1972, A Comparison of Analog and Digital Techniques for Pattern Recognition, in IEEE Proceedings, v. 60, Oct. 1972, pp. 1216-1231.
(Perkin-Elmer Corp., Norwalk, Conn.)

Author Abstract - Electronic, acoustical, and optical analog computers for use in pattern recognition are discussed and their performance compared with that of both general-purpose and special-purpose digital computers. It is shown that the analog computer offers workers using low-precision high-speed one-dimensional or two-dimensional linear discriminant analysis a significant advantage in hardware performance (equivalent bits per second per dollar) over the digital computer in certain limited but important areas. These areas include fingerprint identification, word recognition, chromosome spread detection, earth-resources and land-use analysis, and broad-band radar signal processing. A trend analysis indicates that the advantages of analog computation will probably be overcome in the next few decades by advances in digital-computer hardware.

NASA

QUAM, L.H., 1971, Computer Comparison of Pictures, (Contr. No. SD-183; Rept. No. STAN-CS-71-219, AIM-144, AD-785 172/8), 129 pp.
(Stanford Univ., Dept. of Computer Science, Calif; Advanced Research Projects Agency, Arlington, Va.; National Aeronautics and Space Administration, Washington, D.C.)

Modified Author Abstract - The development is reported of digital computer techniques for detecting changes in scenes by normalizing and comparing pictures which were taken from different camera positions and under different conditions of illumination. The pictures are first geometrically normalized to a common point of view. Then they are photometrically normalized to eliminate the differences due to different illumination, camera characteristics, and reflectance properties of the scene due to different sun and view angles. These pictures are then geometrically registered by maximizing the cross correlation between areas in them. The final normalized and registered pictures are then differenced point by point.

NTIS

QUAM, L.H. and M. J. HANNAH, 1974, Stanford Automatic Photogrammetry Research, (Contr. No. DAHC15-73-C-0435, NAS1-9682; Rept. Nos. STAN-CS-74-472, AIM-254, AD-A005 407), 28 pp.
(Stanford Univ., Dept. of Computer Science, Calif; Advanced Research Projects Agency, Arlington, Va.; National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.)

Abstract - This report documents the feasibility study done at Stanford University's Artificial Intelligence Laboratory on the problem of computer automated serial/orbital photogrammetry. The techniques investigated were based on correlation matching of small areas in digitized pairs of stereo images taken from high altitude or planetary orbit, with the objective of deriving a three-dimensional model for the surface of a planet.

DDC

RAY, R.M., J.D. THOMAS, W.E. DONOVAN, and P.H SWAIN, 1974, Implementation of ILLIAC 4 Algorithms for Multispectral Image Interpretation. Final Report, Mar. 1973 - Feb. 1974, (Contr. No. NGR-14-005-202, DAHC04-75-C-0001; Rept. No. NASA-CR-139214, CAC-112), 26 pp. (Illinois Univ., Center for Advanced Computation, Urbana, Ill.)

Author Abstract - Research has focused on the design and partial implementation of a comprehensive ILLIAC software system for computer-assisted interpretation of multispectral earth resources data such as that now collected by the Earth Resources Technology Satellite. Research suggests generally that the ILLIAC 4 should be as much as two orders of magnitude more cost effective than serial processing computers for digital interpretation of ERTS imagery via multivariate statistical classification techniques. The potential of the ARPA Network as a mechanism for interfacing geographically-dispersed users to an ILLIAC 4 image processing facility is discussed.

NASA/NTIS

R-2

RAYTHEON CO., 1977, Design of a Map Update Capability for Engineer Topographic Units. Final Technical Report, May 77, (Contr. No. DAAG53-76-C-0176; Rept. No. 53-0200-0001, AD-A041 038), 77 pp. (Raytheon Co., Autometric Operation Div., Arlington, Va.)

Author Abstract - This report contains the final conceptual design of two systems for the compilation of Army field map updates using all types of tactical reconnaissance imagery as data input. Both systems are capable of producing Class B output accuracy, and both incorporate innovative design features to improve ease of operation and system throughput. One system is designed to perform a monoscopic solution where the map is used as a source of control to form a terrain model that is combined with the appropriate sensor model to transform image coordinates into their correct ground positions with relief displacement errors removed. The second system uses the mono solution for mono input imagery and a full analytical mapping solution for stereo input imagery. The systems' design evolution, theory of operations, technical characteristics, estimated costs, field deployed van layout, and cost effectiveness comparisons are presented.

DDC

RAYTHEON CO., 1973, Digital Rectification of Side-Looking Radar (DRESLAR). Final Report, Sept. 1973, (Rept. No. ETL-CR-73-18, AD-913 646L).
(Raytheon Co., Autometric Operation Div., Arlington, Va.)

Author Abstract - The purpose of this task was to develop a capability to digitally rectify side looking radar imagery, and to test this capability using data supplied by the TOPO II radar system. The two basic tasks were to develop a computer program, and then test this program using the data supplied. The basic concept of the rectification of side looking radar can be explained as follows. For each point on a side looking radar image, there is a unique corresponding ground point. The determination of this ground point requires that the position and velocity of the radar vehicle be established, that the range to the object be known, and that the height of the ground at the point be known. The position and velocity of the aircraft are determined from fitting an interpolation function to the HIRAN fix data. This function can then be evaluated at the time at which the point was imaged by using the time as computed from the film coordinates of the point. The film coordinates also can be used to derive the range to the target. The elevation of the ground at the point can be determined from a digital terrain model which in turn can be derived from the interferometric data supplied from the radar equipment. Obviously, the position of the point on the ground is not known before rectification as then there would be no need for rectification. Thus an iterative method is used for the rectification process.

ETL BIB

R-4

REGGIORI, G.B., 1972, Digital Computer Transformations for Irregular Line Drawings, (Contr. No. N00014-67-A-0467-0010; Rept. No. TR-403-22, AD-745 015), 180 pp. (New York Univ., Dept. of Electrical Engineering and Computer Science, Bronx, N.Y.)

Author Abstract - The report describes a parametric quantization scheme for irregular line drawings. With this scheme different quantized versions of the same drawing can be obtained by changing the values of the parameters. Three figures of noise are proposed for evaluating the quality of quantized drawings and design formulae are developed for the parameters of the quantization scheme as functions of bounds on the figures of noise. The degradation of the quality of a quantized drawing resulting from a coordinate transformation and requantization is studied in terms of transformed figures of noise. Also, it is shown theoretically and by means of a number of examples how to choose the parameters of the quantization scheme in order to meet the requirements on the transformed figures of noise. This enables one to quantize a preprocessed satellite picture so that after computation of a Mercator projection, the resulting geographic map will have the required quality. The theory presented in this report is applicable to any irregular line drawing and to any transformation defined by a pair of functions that are continuous together with their partial derivatives.

DDC

REY, P.A., Y. GOURINARD, and F. CAMBOU, 1973, Management of Natural Resources in France and Spain by Automatic Cartographic Inventories from ERTS-1 Data. Progress Report, Aug. 1972 - Jan. 1973, (Rept. No. E73-10725, NASA-CR-133069), 80 pp.
(Service de la Carte de la Vegetation CNRS, Toulouse, France)

Abstract - Significant results of the ARNICA program from August 1972 to January 1973 have been: (1) establishment of image to object correspondence codes for all types of soil use and forestry in northern Spain; (2) establishment of a transfer procedure between qualitative (remote identification and remote interpretation) and quantitative (numerization, storage, automatic statistical cartography use of images); (3) organization of microdensitometric data processing and automatic cartography software; and (4) development of a system for measuring reflectance simultaneous with imagery.

NASA/NTIS

R-6

REY, P.A., Y. GOURINARD, and F. CAMBOU, 1974, Management of Natural Resources Through Automatic Cartographic Inventory. Final Report, Aug. 1972 - Jan. 1974, (Rept. No. E74-10518; NASA-CR-138268, Rept.-6), 65 pp.
(Service de la Carte de la Vegetation CNRS, Toulouse, France)

Abstract - Significant correspondence codes relating ERTS imagery to ground truth from vegetation and geology maps have been established. The use of color equidensity and color composite methods for selecting zones of equal densitometric value on ERTS imagery was perfected. Primary interest of temporal color composite is stressed. A chain of transfer operations from ERTS imagery to the automatic mapping of natural resources was developed.

NASA

RHODES, W.T., 1974, Digital Processing of Synthetic Aperture Optical Imagery, in Optical Engineering, v. 13, no. 3, May - Jun. 1974, (Contr. No. 30602-72-C-0409), pp. 267-274.
(Georgia Inst. of Technology, Atlanta, Ga.)

Abstract - A synthetic-aperture approach offers one method for obtaining high resolution optical imagery with low-mass, satellite-based optical telescopes. Images recorded sequentially with different aperture configurations are sampled and digitized, and appropriate spatial-frequency-domain processing is performed on a computer to obtain the desired high-resolution imagery. Special steps can be introduced in these post-detection processing operations that allow a substantial reduction in the optical tolerances that must be maintaned by the aperture elements in the imaging process.

INSPEC/NASA

RICE UNIVERSITY, 1976, Phase 4 of the Rice University Earth Resources Data Analysis Program, Final Report, Jun. 1975 - Jun. 1976, (Contr. No. NAS9-12776; Rept. No. NASA-CR-147826, ICSA-TR-275-025-FPIV), 16 pp. (Rice Univ., Inst. for Computer Sciences and Applications, Houston, Tex.)

Author Abstract - Projects were completed in the development of various pattern recognition algorithms and the development of some general purpose algorithms useful in remote sensing calculations.

NTIS/NASA/ERTS-BIB/GEO-G

RICHARDSON, A.J., and C.L. WIEGAND, 1977, A Table Look-up Procedure for Rapidly Mapping Vegetation Cover and Crop Development, in Proceedings of the 4th Annual Symposium on Machine Processing of Remotely Sensed Data, West Lafayette, Ind., Jun 21-23, 1977, pp. 284-297.
(U.S. Department of Agriculture, Agricultural Research Service, Weslaco, Tex.)

Abstract - A table of 10 LANDSAT data categories has been shown to yield meaningful classifications of vegetation density levels, soil brightness levels, and water without any prior information on local crop and soil conditions. The 10 data categories correspond to water, cloud shadow, low, medium and high reflectivity soil, cloud tops, low, medium and dense plant cover, and a region into which no LANDSAT data may be expected to fall. The 10 categories, developed through analysis of LANDSAT data from six overpass dates, should lead to more rapid machine processing of remote sensing data to furnish crop development surveys and crop yield predictions.

NASA

R-10

RINKER, J.N., J. EHLEN, A.E. KRUSINGER, T.R. CURRIN, and A.O. POULIN, 1977, Capabilities of Remote Sensors to Determine Environmental Information for Combat, (Rept. No. AD-A035139, ETL-0081), 247 pp. (Army Engineer Topographic Labs., Fort Belvoir, Va.)

Abstract - U.S. Army field and technical manuals were used to develop a list of 313 environmental information needs, or factors, required by the Army to accomplish its various tasks. Each factor was evaluated against a list of remote sensing systems to determine the extent to which each system could provide the needed information. Interpretation procedures were restricted to evaluation of imagery by conventional interpretation techniques and equipment. The systems evaluated are LANDSAT (ERTS), radar, thermal infrared, low-level oblique photography, standard photo index sheets, stereo 1:100,000 scale vertical aerial photography, and stereo 1:20,000 scale vertical aerial photography.

NASA/ERTS-BIB/DDC

RISEMAN, E.M., 1978, Automated Semantically Directed Vision Processing and Scene Analysis, (Contr. No. DN223327; N00014-75-C-0459; Rept. No. GQN223327 5) (Univ. of Massachusetts, School of Natural Science and Mathematics, Amherst, Mass.)

Abstract - Automated pattern recognition and scene analysis is of vital interest to the Navy for ultimate applications in command and control in such areas as character recognition, signal classification, and photo analysis. This task is investigating techniques for computer real-time visual scene analysis. The approach includes development of a computational structure for fast parallel reduction of the data present in a scene, techniques for organizing this reduced data in a coherent manner, and the subsequent application of high level contextual and semantic information to the scene analysis problem.

SSIE

R-12

ROBINOVE, C.J., 1977, A Radiometric Interpretive Legend for LANDSAT Digital Thematic Maps, in Photogrammetric Engineering and Remote Sensing, v. 43, May 1977, 2 pp. (U.S. Geological Survey, Reston, Va.)

Abstract - A legend is suggested for use with computer-generated thematic maps made from LANDSAT digital data that designates some of the radiometric characteristics of each thematic map unit as well as the described terrain attributes of each map unit. The relationship between spectral band and radiance for each map unit is shown by a two-dimensional polygon with the four LANDSAT multispectral scanner bands plotted on the ordinate and radiance levels on the abscissa. The resulting shape is colored to correspond with the map unit color, thus facilitating the recognition and understanding of the computer-generated map units.

NASA/GEO-G

ROCHE, C., 1976, Classification Methods Applied to Multispectral Data, in Proceedings of the NATO Advanced Study Institute on Digital Image Processing and Analysis, Bonas, France, Jun 14-25, 1976, pp. 347-60. (ETCA, Fort de Montrouge-Arcueil, France)

Abstract - Some classification algorithms have been applied on LANDSAT multispectral data in the region of the French town of Avignon. The author presents some results of four of the algorithms: linear discrimination, classification through automatic generation of multilevel signature tables, dynamic clusters, and elliptic distance.

INSPEC

ROEHRING, D.R., J.S. MCKNIGHT, and D.A. NICHOLS, 1972, Studies in Remote Sensing Applications. Barriers to Innovation: The Example of Remote Sensing in Urban and Regional Planning in the Los Angeles Metropolis. Interfacing Remote Sensing and Automated Geographic Information Systems. Technical Reports, Sept. 1972, (Contr. No. N00014-69-A-0100-5001; NGL-05-003-404; Rept. No. TR-T-72-2; TR-T-72-3), 69 pp. (California Univ., Dept. of Geography, Riverside, Calif.)

Author Abstract - Some items are presented in a five stage approach which are deemed necessary for employment of remote sensing and automated information systems in a land management program. The approach synthesizes research which has recently led to the development of operational systems.

DDC

ROGERS, R.H., and L.E. REED, 1974, Automated Land-Use Mapping from Spacecraft Data, in Proceedings of American Society of Photogrammetry, 40th Annual Meeting, St. Louis, Mo., March 10-15, 1974, pp. 417-431.
(Bendix Corp., Aerospace Systems Div., Ann Arbor, Mich.)

Abstract - ERTS spectral data were used along with computer land-use classification-recognition techniques to obtain land-use maps of a 625 square mile test site. The land-use classifications chosen were: urban and built-up land, tended grass, extractive land, rangeland, forest land, deep water, shallow water, and nonforested wetlands. The mapping performance (accuracy, repeatability, etc.) satisfied Anderson's (1971) working criteria at publication scales of 1:250,000 and smaller. As the map scale approaches 1:24,000, mapping errors become more apparent. Computer-generated overlays were obtained within a two to three-day time period. These processing speeds, coupled with the fact that ERTS tapes are relatively inexpensive ($160 per ERTS scene) and are available on a routine basis (every 17 days), are believed to provide a significant breakthrough in the art of developing and updating land-use maps.

NASA/GEO-REF

R-16

ROGERS, R.H., L.E. REED, N.J. SHAH, and V.E. SMITH, 1974, Automatic Classification of Eutrophication of Inland Lakes from Spacecraft Data, in Proceedings of the 9th International Symposium on Remote Sensing of Environment, University of Michigan, Ann Arbor, Apr. 15-19, 1974, pp. 981-993
(Bendix Aerospace System Division, Ann Arbor, Mich.)

Abstract - Spacecraft data and computer techniques can be used to rapidly map and store onto digital tapes watershed land-use information. Software is now available by which this land-use information can be rapidly and economically extracted from the tapes and related to coliform counts and other lake contaminants, e.g., phosphorus. These tools are basic elements for determining those land-use factors and sources of nutrients that accelerate eutrophication in lakes and reservoirs.

EIX

ROSENFELD, A., 1977, Extraction of Topological Information from Digital Images, (Grant No. AFOSR-3271-77; Rept. No. TR-547; AD-A042 125/5ST), 35 pp. (Maryland Univ., Computer Science Center, College Park, Md.)

Abstract - Geographic information is commonly derived from remote sensor imagery. The images are digitized and segmented in categories of interest, such as terrain or land use types. The regions resulting from this segmentation process can then be individually labelled, using connected component analysis or refinements of it. Polygonal boundary chains can be constructed for each of these regions, and the topological relationships among the regions can also be extracted.

NTIS

R-18

ROSENFELD, A., 1976, Pattern Analysis of Remotely Sensed Data, (Contr. No. ENG74-22006; Rept. No. GSE 5098 1). (Univ. of Maryland, School of Engineering and Computer Science, College Park, Md.)

Abstract - The proposed research project will be primarily directed toward discrimination of natural from cultural features on remotely sensed imagery. This problem arises in a variety of contexts, and its solution would be of interest to many different classes of users. Those interested in analyzing natural features often find that the presence of cultural features confuses the analysis, and vice versa. A long-term aspect of the proposed program relates to the multispectral nature of much remote sensor imagery, particularly that obtained from the Earth Resources satellites. This imagery contains information in each of several spectral bands; it can thus be regarded as vector-valued imagery, where the components of the vector represent amounts of energy, in the different bands, received from a given terrain location. It would be of considerable interest to extend many of the classical image-processing techniques - for texture analysis, edge detection, etc. - so that they could be directly applied to vector-valued images. This approach would take advantage of the multispectral nature of remotely sensed images; it would be more appropriate than traditional approaches, which apply conventional scalar-valued (grayscale) image-processing techniques to one band at a time, or to principal-component images.

SSIE

ROSENFELD, A., 1977, Pictorial Information Processing and Analysis. Final Report 1 May 72 - 30 Apr 77, (Contr. No. F44620-72-C-0062; Rept. No. AD-A040 149/7ST), 10 pp.
(Maryland Univ., Computer Science Center, College Park, Md.)

Abstract - This paper deals with the specific research activities that were carried out and grouped under six headings: (1) Segmentation of pictures into distinctive regions, (2) Detection of significant local features (such as edges) in a picture, (3) Picture approximation, (4) Picture manipulation and enhancement, (5) Picture processing software, and (6) Picture analysis applications: terrain analysis, cloud pattern recognition.

NTIS

R-20

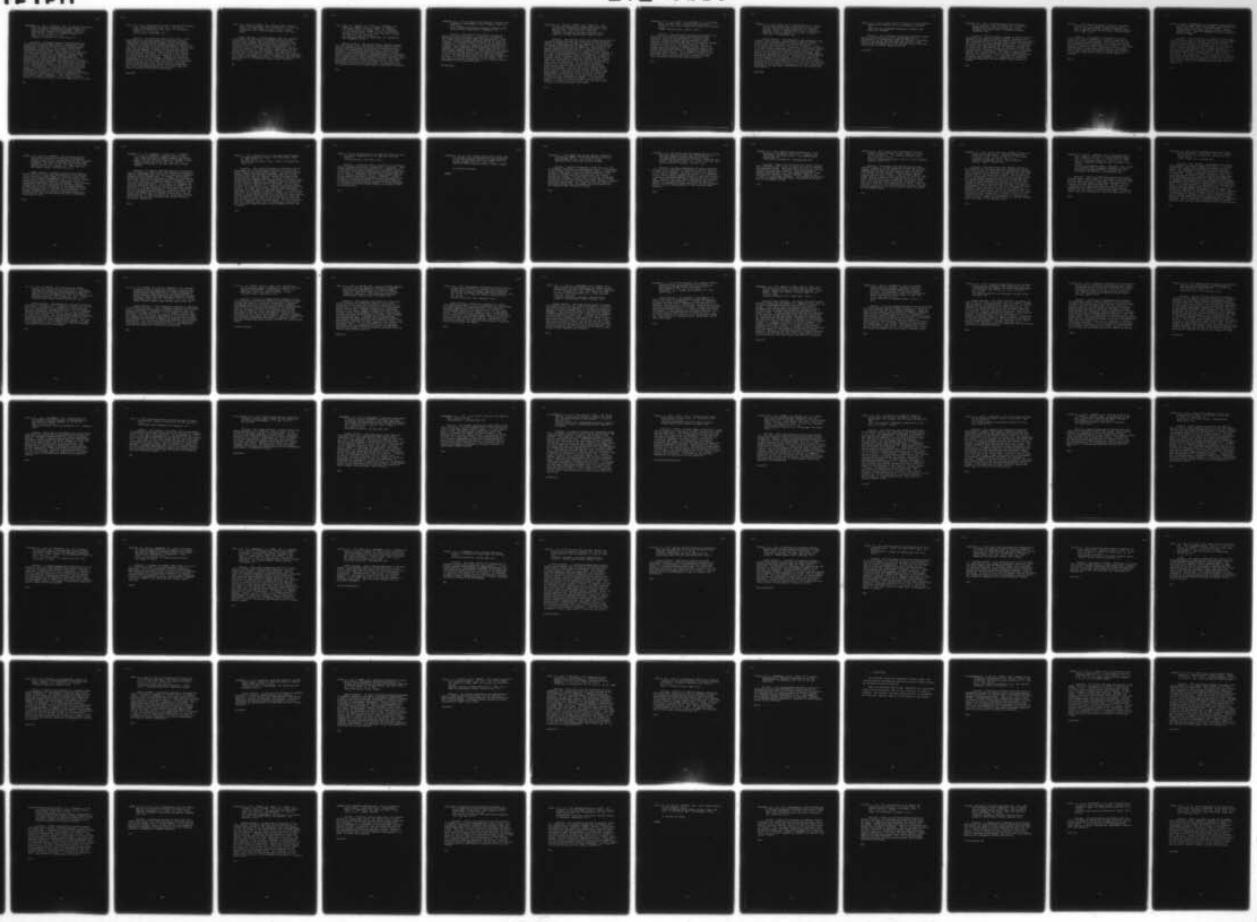
ROSS, M.H., and B.M. WATRASIEWICZ, 1974, A Study on Processing Equipment for Large Arrays, (Rept. No. ESRO-CR(P)-306; ESOC-464/72/AR), 108 pp.
(Cambridge Consultants, Ltd., England)

Author Abstract - Alternatives to earth image array processing by general purpose digital computers are presented and explained. The emphasis is on optical processing techniques, although the use of special purpose electronic hardware as auxiliary processors to general purpose computers is also included. In particular, materials for real time optical processing are described, and the principles of digital-optical processing are investigated.

NASA

AD-A076 148 LOGICAL TECHNICAL SERVICES CORP VIENNA VA F/G 14/5
AUTOMATIC FEATURE EXTRACTION: AN ANNOTATED BIBLIOGRAPHY.(U)
MAY 79 DAAK70-78-C-0195
UNCLASSIFIED ETL-0189 NL

4 OF 5
AD
A076148



ROTHENBERG, D., and E. ELLENTUCK, 1971, An Adaptive Linguistic Model for Pattern Representation and Recognition. Direct Products of Relational Systems. Notes on a Combinational Strategy for Enumeration Problems. Final report, (Contr. No. F44620-70-C0060; Rept. No. AD-716 856), 249 pp. (Inductive Inference Inc., New York, N.Y.)

Abstract - An adaptive pattern representation and recognition system for application to mechanized interpretation of pictorial data from aerial reconnaissance photographs is described. This system differs from conventional pattern recognition systems in that it generates its own features. These features are generated in a decidable subject of the predicate calculus from which they are translated into computer programs. The formulae which define features are generated using quantifiers and logical connectives from a set of atomic predicates which correspond to information about the metric on the sampled input picture. The recognition procedure selects subregions of input pictures and identifies them (i.e., scene analysis). It has provision for an unusual amount of interaction with the trainer to accelerate convergence. The relation between the syntax (formula structure) and semantics (the classes of geometrical figures which satisfy these formulae) is well understood and utilized for rapid convergence. Other papers included extend the system and treat a class of combinatorial problems.

DDC

ROTZ, F.B., 1976, Image Matched Filter Correlator Experiments. Final Technical Report, Jul. 1975 - Jun. 1976, (Contr. No. F30602-75-C-0305; Rept. No. AD-A030025, RADC-TR-76-219), 113 pp.
(Harris Corp., Melbourne, Fla.)

Abstract - The work described in this report is the continuation of the development of an automatic stereo compilation system based on coherent optical techniques. A breadboard coherent optical mapping system was modified to improve its accuracy and overall performance while at the same time simplifying the basic optics involved. Methods for preprocessing imagery to enhance correlation performance were studied and phase-type spatial filters were used to increase optical efficiency. The problem of data readout was investigated with particular attention to the use of an optical heterodyne technique. Computer and interface requirements for a fully automatic breadboard system were established and the use of real time filters was considered. Results indicate that this coherent optical system has considerable promise in the area of parallax measurement and, with slight modification, may be a useful tool for feature extraction from aerial photographs.

NASA/NTIS

ROTZ, F.B., and M.O. GREER, 1972, Mission Review Screener, Final Technical Report, May 1971-May 1972, (Contr. No. F30602-71-C-0280; Rept. No. AD-747 803), 144pp. (Radiation, Inc., Electro-Optics Center, Ann Arbor, Mich.)

Author Abstract - An experimental study was conducted to determine the feasibility of automatically plotting reconnaissance imagery and automatically evaluating image quality using coherent optical processing techniques. The plotting sensitivity was determined experimentally as a function of filter bandwidth, scale, orientation, scene contrast and camera tilt. The effect of image quality on the correlation process was also studied. The experiments indicated that it was feasible to perform the plotting function optically to an accuracy of 1/600 of a frame in both directions at a speed of 50 frames per minute. Processing rates for the image quality of 20 frames per second or more should be possible.

DDC

RUIZ, R.M., D.A. ELLIOTT, G.M. YAGI, R.B. POMPHREY, M.A. POWER, W. FARRELL, JR, J.J. LORRE, W.D. BENTON, R.E. DEWAR, and L.E. CULLEN, 1977, IPL Processing of the Viking Orbiter Images of Mars, in Journal of Geophysical Research, v. 32, Sept. 30, 1977, (Contr. No. NAS7-100), pp. 4189-4202.
(California Institute of Technology, Jet Propulsion Lab, Pasadena, Calif.)

Author Abstract - The Viking orbiter cameras returned over 9000 images of Mars during the 6-month nominal mission. Digital image processing was required to produce products suitable for quantitative and qualitative scientific interpretation. Processing included the production of surface elevation data using computer stereophotogrammetric techniques, crater classification based on geomorphological characteristics, and the generation of color products using multiple black-and-white images recorded through spectral filters. The image processing laboratory of the Jet Propulsion Laboratory was responsible for the design, development, and application of the software required to produce these 'second-order' products.

NASA

SCHAEFER, D.H., 1976, Automated Data Handling Techniques and Components (High Capacity Data Systsms), (Rept. No. ZH-2115-5).
(U.S. National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.)

Abstract - The focus of this RTOP is to develop methods of on-board analysis of image data generated by earth observation and other image sensing missions. Under this RTOP, parallel image processing systems are being developed. Such systems process all points of an image simultaneously. Priority is being given to the development of a digital type of parallel image processing known as a tse computer. Such computers are two dimensional analogs of conventional digital computers. These computers will process from sixteen thousand to one million points simultaneously. It is the aim of this RTOP to develop computing systems suitable for spacecraft on-board use that have an effective bit rate of 10 to the 12th power bits per second. Real time image processing systems that utilize coherent optical phenomena are also being developed.

HEL-RSG/SSIE

SCHALLER, E.S., and R.W. TOWLES, 1975, IMAGE 100: The Interactive Multispectral Image Processing System, in NASA Earth Resources Survey Symposium, v. 1-B, Houston, Tex., Jun. 1975, pp. 1274-1291. (National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, Tex.)

Abstract - The need for rapid, cost-effective extraction of useful information from vast quantities of multispectral imagery available from aircraft or spacecraft has resulted in the design, implementation and application of a state-of-the-art processing system known as IMAGE 100. Operating on the general principle that all objects or materials possess unique spectral characteristics or signatures, the system uses this signature uniqueness to identify similar features in an image by simultaneously analyzing signatures in multiple frequency bands. Pseudo-colors, or themes, are assigned to features having identical spectral characteristics. These themes are displayed on a color CRT, and may be recorded on tape, film, or other media. The system was designed to incorporate key features such as interactive operation, user-oriented displays and controls, and rapid-response machine processing. The user can readily control and/or modify the analysis process based on his knowledge of the input imagery. Effective use can be made of conventional photographic interpretation skills and state-of-the-art machine analysis techniques in the extraction of useful information from multispectral imagery. This approach results in highly accurate multitheme classification of imagery in seconds or minutes rather than the hours often involved in processing using other means.

GEO-G

SCHAPPELL, R.T., J.C. TIETZ, R.L. HULSTROM, R. A. CUNNINGHAM, and G. M. REEL, 1976, A Preliminary Experiment Definition for Video Landmark Acquisition and Tracking, 83 pp.
(Martin Marietta Corp., Denver, Colo.)

Abstract - Six scientific objectives/experiments were derived which consisted of agriculture/forestry/range resources, land use, geology/mineral resources, water resources, marine resources and environmental surveys. Computer calculations were then made of the spectral radiance signature of each of 25 candidate targets as seen by a satellite sensor system. An imaging system, capable of recognizing, acquiring and tracking specific generic type surface features was defined. A preliminary experiment definition and design of a video Landmark Acquisition and Tracking system is given. This device will search a 10-mile swath while orbiting the earth, looking for land/water interfaces such as coastlines and rivers.

GEO-G

SCHMIDT, R.G., B.B. CLARK, and R. BERNSTEIN, 1976, A Search for Sulfide-Bearing Areas Using LANDSAT-1 Data and Digital Image-Processing Techniques--in Pakistan, in NASA, Lyndon B. Johnson Space Center - NASA Earth Resources Survey Symposium, v.1-B, pp. 1013-1027. (IBM Corp., Gaithersburg, Md.)

Author Abstract - Two experiments were conducted using LANDSAT-1 multispectral scanner data to identify ground features that are indicators of sulfide-bearing rock. A nearby known sulfide deposit was used as a control. In the first experiment, false-color composites were examined visually to locate possible favorable areas; in the second, favorable areas were classified by digital-computer processing. The results of the experiment show that outcrops of hydrothermally altered and mineralized rock can be identified from LANDSAT-1 data under favorable conditions. The empirical method of digital-computer classification of the multispectral scanner data was relatively unrefined and rapid. The five mineralized prospecting sites identified are in locations that the geologist would not have selected as favorable on the basis of geologic knowledge or photogeologic interpretation at the time of the investigation.

NASA/COMP

SCHULZ, B.S., 1978, Digital Image Processing in Photogrammetry. Application Possibilities for Cartographic Problems, 5 p.
(Institut Fuer Angewandte Geodaesie, Frankfurt-am-Main, West Germany)

Abstract - The suitability of an edge extraction method for the data reduction of aerial photographs and its applicability to cartographic tasks are examined. Procedures based on this method are described and applied to image analysis and determination of the different natures of land use by means of digital image processing.

NTIS/NASA

S-6

SHAPIRO, L.G., 1978, A General Spatial Data Structure, in Proceedings of the 1978 Conference on Pattern Recognition and Image Processing, pp. 238-49. (Kansas State Univ., Dept. of Computer Science, Manhattan, Kans.)

Abstract - The processing of images to extract regions, boundaries, and objects creates a spatial database which contains large quantities of information consisting of objects, their attributes, their locations, and spatial relationships. The problem of representing such spatial data in a uniform structure from which queries may be answered, commands may be carried out, and matching may be performed is dealt with. A spatial data structure is defined and its use in representing map data is illustrated. The kinds of manipulations required in a spatial data base to answer queries about spatial data are discussed. It is then shown that matching of spatial data structures is a mathematical problem of finding homomorphisms from one spatial data structure to another.

NASA

SHLIEN, S., 1975, Practical Aspects Related to Automated Classification of LANDSAT Imagery Using Lookup Tables, in Canada Centre for Remote Sensing, Department of Energy, Mines and Resources, Research Report 75-2, 1975, 15 pp.

Abstract - The computer time needed to classify LANDSAT data can be reduced by an order of magnitude by employing a table lookup scheme. The method is practical on any general purpose computer since it does not require special hardware or a great deal of core memory. This paper presents a description and illustration of a particular implementation of the table lookup scheme using hashing tables, and a mathematical model, relating the statistics of a LANDSAT image to the size of a lookup table, is examined.

GEO-G

S-8

SHLIEN, S. and D. GOODENOUGH, 1973, Automatic Interpretation of ERTS-A Imagery Using the Maximum Likelihood Decision Rule, (Rept. No. RR-73-2, PB-238 840/3ST), 30 pp. (Canada Centre for Remote Sensing, Ottawa, Ontario; Waterloo Univ., Dept. of Management Sciences, Waterloo, Ontario, Canada)

Abstract - The feasibility of automatic ground cover classification using the spectral intensities from the ERTS-A images was investigated. The Maximum Likelihood Decision Rule was applied with the assumption that the spectral intensities are Gaussian random variables for any specific class. Methods of applying the divergence measure to determine the separability of the classes and selecting the most useful bands for distinguishing the classes were described. The schemes were applied to three test sites in Manitoba and Saskatchewan. It was found on the basis of the training areas for which ground information was available that there is sufficient information in the four spectral bands of one frame to discriminate the different types of vegetation.

NTIS

SHLIEN, S., and A. SMITH, 1975, A Rapid Method to Generate Spectral Theme Classification of LANDSAT Imagery, in Remote Sensing of Environment, v. 4, no. 1, 1975, pp. 67-77.
(Canada Centre for Remote Sensing, Ottawa, Canada)

Abstract - A new table look up scheme was designed and implemented to reduce the computation time for the classification using the maximum likelihood Gaussian decision rule. High correlation of the spectral intensities in the four multispectral scanner bands reduces the number of distinct intensity vectors in an image to the order to several thousands compared with over 16 million possible vectors. This made it feasible to store the distinct vectors together with the ground cover classification in the computer's core memory. This table look up scheme permits classification of LANDSAT imagery at least an order of magnitude faster than conventional methods without compromising accuracy or requiring special computer hardware.

EIX

S-10

SIMONETT, D.S., 1974, Quantitative Data Extraction and Analysis of Remote Sensor Images, in Remote Sensing Techniques for Environmental Analysis, pp. 51-81. (Earth Satellite Corp., Washington, D.C.)

Abstract - The statistical and computer techniques are reviewed for extracting quantitative information from remote sensing data. Background information is provided on the technological aspects of remote sensing, and a detailed description is presented of the five principal steps in pattern recognition, namely (1) input of the initial patterns; (2) pattern preprocessing; (3) feature extraction; (4) decision/classification function; and (5) output of the classification. The conceptual and pragmatic considerations involved in the various procedures for enhancing, processing, and outputting data are discussed and evaluated. Comparisons are made between simple and complex procedures for data extraction and their respective advantages and limitations are assessed.

GEO-REF

SKALEY, J.E., and R.J. HOFFMANN, 1973, Deriving Spectral and Spatial Features to Establish a Hierarchical Classification System, in Proceedings of the Conference on Machine Processing of Remotely Sensed Data, West Lafayette, Ind., Oct. 16-18, 1973, pp. 4B-1 to 4B-5. (Cornell University, Ithaca, N.Y.; USAF, Rome Air Development Center, Griffiss AFB, N.Y.)

Author Abstract - Automatic processing of remotely sensed data has to date been constrained to using training sets to classify a small number of categories within the context of a limited geographical area. In order to promote a more flexible user-oriented data processing system, a hierarchical taxonomic structure is proposed. This structure incorporates data inputs from several different sensors together with a priori information on the characteristics of different materials of interest to facilitate efficient design of feature sets to classify those materials. A Boolean approach may be used to assign these feature sets including both spectral and spatial criteria to different hierarchical levels.

NASA

S-12

SOLOMON, S.I., A.S. AGGARWAL, T. NAZAR, and T. CHADWICK, 1977, Use of Topographic Data for Land-Use/Land-Cover Identification by LANDSAT Imagery, in Proceedings of the 4th Canadian Symposium on Remote Sensing, Quebec, Canada, May 16-18, 1977, pp. 158-162. (Canadian Aeronautics and Space Institute, Ottawa, Canada)

Abstract - To improve land-use/land-cover identification for hydrologic applications, the authors have conducted computer experiments that are based on combining topographic information with LANDSAT data. A software system called WATMAP was specifically developed to handle map information. The system allows the storage of digital topographic, geological, soil, land-use or land-cover data on a spatially distributed square grid basis. As is known, the incoming and reflected radiation from an area detected by LANDSAT is influenced to a certain degree by the slope and slope orientation of the area being considered. It appears, therefore, that by superimposing the slope and slope orientation obtained from WATMAP onto the LANDSAT information, a better identification of land-use/land-cover can be made and that the results can be used to periodically update land-use/land-cover information.

GEO-G

STARK, H., 1978, Application of an Optical-Digital Computer to Image Processing, (Contr. No. ENG78-05902; Rept. No. GSE 4241 4).
(Rensselaer Polytechnic Inst., School of Engineering, Troy, N.Y.)

Abstract - This research program is concerned with the development of an optical-digital computer for processing aerial imagery and radiographic images. The optical-digital computer unites the parallel processing capability of an optical system with the inherent logical and computational advantages of a digital computer. A basic version of the optical-digital computer was assembled under a previous grant. It consists of a coherent and incoherent optical system that enables parallel preprocessing of the image. On the basis of these initial results, it is proposed to continue further research into image processing. Texture image masking will be applied, as a next step, to high-resolution aerial images including rural Connecticut and ERTS imagery. A least-squares algorithm for extracting estimates of number and size of profusions in pneumoconioses films from the spatial power spectrum will be applied. Data compression techniques for analyzing the resultant feature vectors with an eye towards pictorial pattern recognition will be investigated. This is a continuation of a research effort that was previously supported at Yale University under National Science Foundation Grant ENG 77-038263.

SSIE

STARK, H., 1974, An Optical-Digital Image Processing System, in Optical Engineering, v. 13, May-Jun. 1974, pp. 243-249.
(Yale University, New Haven, Conn.)

Abstract - An optical-digital processor for performing image processing and pattern recognition is discussed. Some of the features of this processor are (1) a capability for interactive processing by including an interactive supervisor in the loop; (2) parallel preprocessing of large amounts of data by optical techniques; and (3) 'fine-grained' analysis of the reduced data base by a digital computer. Several innovative data-reducing operations easily implemented with an optical system are described. A particular design for an interactive optical-digital computer now being assembled is discussed and several actual examples of optical preprocessing are given.

NASA

STEINER, D. et al, 1975, Digital processing of Image Data for Automatic Terrain Recognition, in Proceedings of the 2nd Canadian Symposium of Remote Sensing, Ottawa, Canada, 1974, v. 1, pp. 59-75. (Canadian Remote Sensing Society, Ottawa, Canada)

No Abstract Available

GEOREF

S-16

STEINER, D., 1973, Remote Sensing and Spatial Information Systems, in COSPAR, 16th Plenary Meeting, Konstanz, West Germany, May 23 - Jun 5, 1973, 24 pp. (Waterloo Univ., Waterloo, Ontario, Canada)

Abstract - Spatial information systems deal with data on phenomena distributed in geographical space. An assessment of the present state-of-the-art regarding spatial information systems is presented, giving particular attention to the problem of integrating remote sensing data into spatial information systems. The principles of spatial information systems are considered, taking into account aspects of data specification, data acquisition, data input, storage, retrieval, processing, and output. The image data storage problem is discussed together with the geometrical base problem and the thematical data extraction problem.

NASA

STEPHENS, C.W., 1972, Multi-Spectral Imaging Sensor--Vidicon Spectral Signature System, in Proceedings of the Sixteenth Annual Technical Meeting on Optical Instrumentation Engineering in Science, Technology and Society, San Mateo, Calif., Oct. 16-18, 1972, pp. 65-70. (Martin Marietta Aerospace, Orlando, Fla.)

Abstract - By using combinations of several selected portions of the spectrum the contrast of certain objects in a scene can be enhanced. A system utilizing this approach can be called a spectral signature system. It is possible to use a three-channel imaging sensor to create the data and a specially developed computer to process the data in real time. Questions of sensor signal formulation are discussed together with a round detector, a rectangular detector, aspects of fundamental vidicon operation, vidicon transducer action, vidicon interdependencies, and consistent model equations.

NASA

S-18

STEPLER, P.F., 1973, BUDAK Program Documentation, XY to Geographic Coordinates, Version 1. (2400 ft. Mag. Tape, Rept. No. PB-223 180/1. For Documentation, see PB-223 179)
(IBM Federal Systems Div., Gaithersburg, Md.)

Abstract - BUDAK is an IBM System 360 Fortran program that transforms X and Y data in counts per inch to latitude and longitude values. Map projections which can be inverted include the following - Mercator, Polar Stereographic, Lambert Conformal Conic with two standard parallels, Transverse Mercator Sphere, Transverse Mercator Spheroid and Kavraisky IV Conic Equal Interval. This program was originally used to create World Data Bank I (Accession No. PB-223 178) of the AUTOMAP system.

NTIS

STEPLER, P.F., 1975, Graphic Data Presentation and Edit (GADPET) Program-A User's Guide, (Rept. No. PB-244 906/4, CIA/CP-75/2. For system on magnetic tape, see PB-244 905), 57 pp.
(Central Intelligence Agency, Office of Joint Computer Support, McLean, Va.)

Abstract - The graphic data presentation and edit (GADPET) program is an IBM System 360 Fortran and assembler language program which was developed to allow the user to interactively display and edit map-type data on the IBM 2250 cathode ray tube terminal. IBM's graphic support package subroutines are used to interface with the IBM 2250. GADPET permits a number of map editing functions to be performed interactively such as combining two or more lines into a new line with proper direction, extending a line, deleting a complete line, deleting points from a line, adding points to a line, and constructing a new line. The program was developed as an aid for creating World Data Banks of the AUTOMAP system.

NTIS

S-20

STEPLER, P.F., 1975, Rotate and Scale (ROTSAL) Program for Cartographic Application - Program Documentation, (Rept. No. PB-244 904/9, CIA/CP 75/1A. For system on magnetic tape, see PB-244 903), 61 pp. (Central Intelligence Agency, Office of Joint Computer Support, McLean, Va.)

Abstract - The rotate and scale (ROTSAL) program is an IBM System 360 Fortran program for cartographic application which accepts as input the raw digitized X-Y coordinate data, performs several automatic map editing functions, and outputs data in the graphic data format. The program also allows for automatic I/O error recovery from illegal characters of incomplete records in the raw digitized map data. The automatic map editing functions are: rotate the data through an angle determined by the position of the three corners of the map; scale calibrate the data from digitizer measurements; offset and shift the data from digitizer measurements; offset and shift the data to an origin of 0,0; eliminate duplicate points; check the distance between consecutive data points and either discard the point, or create additional points between the two values; close lines for islands and lakes; and allow for partial or complete deletion of a line. ROTSAL was developed as an aid for creating World Data Banks of the AUTOMAP system.

NTIS

STEPLER, P.F. and W.E. SCHMIDT, 1975, Cartographic Automatic Mapping (CAM) User's Guide Program Documentation - Version 4, (Rept. No. PB-251 390/1SL, OGCR-CD-75-1; supersedes report no. BGI-DC-75-1A. For computer programs on magnetic tape, see PB-238 357), 119 pp.
(Central Intelligence Agency, Washington, D.C., Office of Geographic and Cartographic Research; National Technical Information Service, Springfield, Va.; IBM Federal Systems Div., Gaithersburg, Md.)

Abstract - CAM is an IBM System 360 Fortran program that performs a wide variety of cartographic plotting tasks. It will connect points with straight lines or great circles and will draw line grids, range rings, ellipses, cones, azimuths and many other map features. Included also are a selection of 17 map projections that can be used in conjunction with either an 8,200 point world shoreline found on the CAM tape or from World Data Bank I of 100,000 points separately contained on accession number PB-223 178.

NTIS

S-22

STOCKMAN, G., 1978, Toward Automatic Extraction of Cartographic Features. Final Report, Jul. 78, (Contr. No. DAAK70-77-C-0110; Rept. No. AD-A059 942, ETL-0153), 129 pp.
(L.N.K. Corp., Silver Spring, Md.)

Abstract - The problem of automatically extracting map symbology from source imagery is studied. It is concluded that a great deal of geographic knowledge used by humans, who currently perform this extraction function, must be made available to machines before the function can be automated. Several geographic knowledge sources are discussed and an attempt is made to define paradigms under which knowledge can be encoded and used in the computer. An automatic cartographic feature extraction system (ACES) is sketched which represents a best framework for continuing development on this difficult problem given current achievements. A systems approach is taken with first consideration given to desired outputs and available inputs. It is concluded that input/output technology is far in advance of technology available for interpretation of the data. Emphasis is placed on the use of knowledge by ACES during automatic interpretation of imagery. Many types of knowledge typically used by humans appear difficult to engineer into automatic processes. Use of positional knowledge encoded in a geographic data base (GDB) is selected as the most promising avenue. Proposals are given for future research work in that direction.

DDC

STRUVE, H., 1977, An Automated Procedure for Slope Map Construction. Volume I. Description and Instructions for Use of the Automated Procedure, (Rept. No. WES-TR-M-77-3-VOL-1, AD-A047 794/3SL. See also v. 2, AD-B023 657L), 104 pp.
(Army Engineer Waterways Experiment Station, Vicksburg, Miss.)

Abstract - An automated procedure for constructing slope maps was developed and demonstrated in this study. The procedure consists of three sequential parts - (1) input of surface elevation values by means of a matrix of elevation values referred to as an elevation grid array, (2) calculation of slope magnitudes and directions by the computer program SLOPEMAP, and (3) construction of slope maps using various SLOPEMAP output products. The form of input elevation data selected for use by SLOPEMAP to be prepared in advance of a program execution is an orthogonal two-dimensional matrix, each element of which is the elevation of the topographic surface at that matrix or grid point. At run time, SLOPEMAP inputs these elevation values and calculates the slope magnitude and direction of each input grid point by employing approximation methods that use the elevation values of the grid point in question and its nearest and next nearest neighbors. Then, depending on the selected user options, the calculations are recorded or displayed in one or more of the following forms - (1) printer swath dumps, (2) magnetic tapes, (3) punched cards, and/or, (4) drum or cathode ray tube CRT graphic plots that delineate slope classes selected by the user.

DDC

S-24

STRUVE, H., W.E. GRABAU, and H.W. WEST, 1977, Acquisition of Terrain Information Using LANDSAT Multispectral Data. (Rept. No. WES-TR-M-77-2-1; AD-A042 999), 53 pp. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.)

Author Abstract - This report provides an analytical capability for correcting the spectral data, as received by LANDSAT, to radiance values at ground level. Variations in the radiance values as influenced by atmospheric effects, terrain geometry, and shadows are coupled together to form a single equation that converts the radiance values of images obtained at different times to a common datum.

DDC

SU, M.Y. and R.E CUMMINGS, 1972, Multispectral Remote Sensing Data, Using Two-Part Statistical Clustering Technique of Sequential Variance Analysis, in Proceedings of the 8th International Symposium on Remote Sensing of the Environment, Oct. 2-6, 1972, pp. 861-879. (Northrop Services, Inc., Huntsville, Ala.; NASA, Marshall Space Flight Center, Huntsville, Ala.)

Author Abstract - Description of a two-part clustering technique consisting of (a) a sequential statistical clustering, which is essentially a sequential variance analysis, and (b) a generalized K-means clustering. In this composite clustering technique, the output of (a) is a set of initial clusters which are input to (b) for further improvement by an interactive scheme. This unsupervised composite technique was employed for automatic classification of two sets of remote multispectral earth resource observations. The classification accuracy by the unsupervised technique is found to be comparable to that by traditional supervised maximum-likelihood classification techniques.

NASA

S-26

SU, M.Y., R.R. JAYROE, JR., AND R.E. CUMMINGS, 1972, Automatic Classification by Sequential Statistical Variance and K-Means Clustering Techniques for Remote Multispectral Earth Resource Observation Data, in Remote Sensing of Earth Resources; Proceedings of the Conference on Earth Resources Observation and Information Analysis Systems, Tullahoma, Tenn., Mar. 13 - 14, 1972, v. 1., pp. 673-693. (NASA, Marshall Space Flight Center, Huntsville, Ala.)

Author Abstract - A new clustering technique is presented. It consists of two parts: (a) a sequential statistical clustering which is essentially a sequential variance analysis, and (b) a generalized k-means clustering. In this composite clustering technique, the output of (a) is a set of initial clusters which are input to (b) for further improvement by an iterative scheme. This unsupervised composite technique was employed for automatic classification of two sets of remote multispectral earth resource observations. The classification accuracy by the unsupervised technique is found to be comparable to that by existing supervised maximum likelihood classification technique.

NASA

SU, M.Y., J.C. POOLEY, and C.G. HAND, 1970, Statistical Algorithms and Computer Programs for Analysis of Multi-Spectral Observations. Final Report, (Contr. No. NAS8-25182; Rept. No. NASA-CR-103182), 176 pp. (Northrop Corp., Huntsville, Ala.)

Abstract - The use of change analysis methods for the classification of resolution elements in multispectral remote sensing data analysis by pattern recognition is discussed. An algorithm based on a principle of inventory boundary enhancement which involves area smoothing and taking absolute value of the two directional difference of the smoothed data was developed as well as an algorithm based on the statistical variation of the multispectral data and the confidence of the statistical estimation. Computer programs are described which extend the automatic data flow compression, and signature enhancement techniques are applied to multi-spectral scanner data taken from an aircraft over agricultural fields.

INSPEC/NTIS/NASA

S-28

SUNG, Q.C., and L.D. MILLER, 1977, Land Use/LANDSAT Mapping 1:25000 of Taiwan, Republic of China by Automated Multispectral Interpretation of LANDSAT Imagery, (Rept. No. NASA-TM-X-71382; X-923-77-210), 182 pp. (National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.)

Abstract - Three methods were tested for collection of the training sets needed to establish the spectral signatures of the land uses/land covers sought due to the difficulties of retrospective collection of representative ground control data. Computer preprocessing techniques applied to the digital images to improve the final classification results were geometric corrections, spectral band of image ratioing, and statistical cleaning of the representative training sets. A minimal level of statistical verification was made based upon the comparisons between the airphoto estimates and the classification results. The verifications provided a further support to the selection of MSS bands 5 and 7. It also indicated that the maximum likelihood ratioing technique can achieve more agreeable classification results with the airphoto estimates than the stepwise discriminant analysis.

NASA/NTIS

SWAIN, P.H., 1977, Advancements in Machine-Assisted Analysis of Multispectral Data for Land Use Applications, in Proceedings of the 4th Annual Symposium on Machine Processing of Remotely Sensed Data, West Lafayette, Ind., Jun. 21-23, 1977, (Rept No. USGS-14-08-0001-14725), pp. 336-343.
(Purdue University, West Lafayette, Ind.)

Author Abstract - Results are reported on a three-year study participated in by the Laboratory for Applications of Remote Sensing of Purdue University, the Center for Advanced Computations of the University of Illinois, and the Geographic Applications Program of the U.S. Geological Survey. The outcome of the study has been a demonstration of the feasibility of applying digital analysis of satellite data to land use inventory and mapping. Advancements have been made in the areas of data analysis techniques, data processing products, and education and training of personnel within the potential user agency.

NASA

S-30

SWAIN, P.H., C.L. WU, D.A. LANDGREBE, and H. HAUSKA, 1975, Layered Classification Techniques for Remote Sensing Applications, in NASA Earth Resources Survey Symposium, v. 1-B, Houston, Tex., Jun. 1975, (Rept. No. LARS-IN-061275; NASA-TM-X-58168-Vol-1-B, JSC-09930-Vol-1-B), pp. 1087-1097
(National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, Tex.)

Author Abstract - The single-stage method of pattern classification utilizes all available features in a single test which assigns the unknown to a category according to a specific decision strategy (such as the maximum likelihood strategy). The layered classifier classifies the unknown through a sequence of tests, each of which may be dependent on the outcome of previous tests. Although the layered classifier was originally investigated as a means of improving classification accuracy and efficiency, it was found that in the context of remote sensing data analysis, other advantages also accrue due to many of the special characteristics of both the data and the applications pursued. The layered classifier method and several of the diverse applications of this approach are discussed.

GEO-G

SWANLUND, G., 1972, Hybrid Techniques for Automatic Imagery Interpretation, in Proceedings of the Seminar on Operational Remote Sensing, American Society of Photogrammetry, Feb. 1-4, 1972, 256pp. (Honeywell, Inc., Systems and Research Div., Roseville, Minn.)

Author Abstract - The purpose of this paper is to review the status of techniques which could automate portions of the data interpretation. A variety of laboratory equipment has been used to demonstrate the feasibility of automatic classification. Results have shown classification accuracies approaching those of humans. Hardware projections indicate processing rates 1 to 3 orders of magnitude faster than humans. A few programs have evaluated prototype units to process multispectral data on an extensive scale. In the main, however, the field has to be considered as emerging. Much research is required before operational systems can be developed.

NASA

T-1

TENENBAUM, J.M., T.D. GARVEY, S. WEYL, and H.C. WOLF, 1974, An Interactive Facility for Scene Analysis Research--Graphic Computer System for Pictorial Analysis. Final Report, (Contr. No. N00014-71-C-0294; Rept No. AD-774711), 49pp.
(Stanford Research Inst., Menlo Park, Calif.)

Modified Author Abstract - The report describes initial progress towards the development of a computer system that can be rapidly programmed to analyze any class of pictorial scenes. It has been awkward to develop scene analysis programs using conventional programming systems because of the difficulty of formalizing pictorial descriptions in symbolic terms. Picture processing techniques are inherently ad hoc and must be deduced empirically for each application. An interactive system specifically designed for expressing and experimenting with perceptual strategies is constructed. The system allows an experimenter to describe basic perceptual concepts to a computer in terms of pictorial examples. The examples are designed graphically by encircling areas of a displayed scene with a cursor. A concept is represented internally by values of primitive feature-extraction operators that distinguish it from examples of previously defined concepts. Concepts so defined constitute a common vocabulary, shared by man and machine, that can be used symbolically in describing objects and specifying scene analysis procedures.

NASA/NTIS

TESSAR, P.A., and J.C. EIDENSHINK, 1977, The LANDSAT Imagery Analysis Package - Automated Land Use Classification and Multidimensional Geographic Analysis, in Proceedings of the Second Annual William T. Pecora Memorial Symposium; Mapping with Remote Sensing Data, Sioux Falls, S. Dak., Oct. 25-29, 1976, pp. 172-200. (South Dakota State Planning Bureau, Pierre, S. Dak.)

Abstract - A set of computer programs has been developed to process LANDSAT computer compatible tapes; the analytic tool has been used for land resource management. Among the functions performed by the programs are computer compatible tape joining and reformating, production of consecutive scene mosaics, spectral analysis, data rectification, ground truth acquisition and training field selection. In addition, analytic procedures such as clustering, large-area classification, data cleaning, misclassification correction and preparation of line printer displays at reduced scale are incorporated in the system. Multidimensional resource analysis permits production of soil stability maps, land use change assessments and water quality planning surveys.

NASA

T-3

TISDALE, G.E., 1977, A Digital Image Processor for Automatic Target Cueing, Navigation, and Change Detection, in Proceedings of the Seminar on Airborne Reconnaissance - Tactical/Real Time, Reston, Va. Apr. 18-21, 1977, pp. 112-119.
(Westinghouse Defense and Electronic Systems Center, Baltimore, Md.)

Author Abstract - This paper describes the design and application of a digital processor for the automatic recognition of targets in reconnaissance images and for the precise registration of two images of the same terrain area. The problems of information extraction and bandwidth reduction in raw sensor data are considered and how they lead to the evolution of a common preprocessing approach. Three applications of the preprocessed data are then examined: (1) automatic cueing of targets in sensor displays, (2) automatic registration between images to update navigation systems or to correct image geometry, and (3) detection of the changes between image sequences. The paper concludes with a discussion of the combined use of recognition and registration functions in targeting problems.

NASA

TISDALE, G.E., 1971, A Versatile Technique for the Automatic Extraction of Information from Reconnaissance Images, in Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 17-19, 1971, pp. 166-71. (Westinghouse Defense and Space Center, Baltimore, Md.; IEEE Aerospace and Electronics Group, Dayton Section, Dayton, Ohio)

Abstract - Extraction of information from airborne reconnaissance images involves several related operations, including the location and identification of specific target classes or terrain configurations, and the registration between images of the same scene for purposes of accurate positioning, multisensor evaluation, or change detection. Complications are introduced, because images may be obtained from sensors having different spectral sensitivity and under various conditions of illumination, orientation, scale, and aspect angle. This paper describes a digital image processing technique that performs operations of this kind automatically, under realistic conditions. It is, in essence, a pattern recognition technique. Although its operation is currently being computer-simulated, it is intended for implementation as a compact, special-purpose processor, having an overall rate of operation exceeding one picture element per mu-sec.

INSPEC

T-5

TONELLI, A.M., 1978, Surface Texture Analysis with Thermal and Near Infrared Scanners, in Photogrammetric Engineering and Remote Sensing, v. 44, no. 10, Oct. 1978, pp. 1273-1278.
(Rossi A.R. Co. s.r.l., Milano, Italy)

Abstract - Texture analysis applied to scannings collected in the domain of reflected and emitted infrared radiance can be usefully employed for detecting glacial crevasses and fault lines, and for monitoring the current pattern at the sea's surface. Such an analysis, performed by high frequency extraction from scanning data followed by multistage logarithmic compression, enhances very subtle discontinuities existing at the surfaces in the field of reflection and emission. The contribution of the numerous phenomena involved can often be distinguished by the study of the correlation between the 1 to 2 micrometer and 9 to 11 micrometer channels. This method seems particularly useful in sensing the input of small volumes of water into the sea. It is useful for establishing a model for current circulation when bathymetric data are also used. While a number of appropriate methods have been developed for the mapping of faults, the thermal texture analysis method seems to be a promising tool for use in the study of glaciers, enabling the location of crevasses to be drawn on a map.

Handsearch

TRELINSKIE, E.G. and L.P. MURPHY, 1977, Multi-Image Interpretation Device, (Contr. No. DA08068; Rept. No. ZQA 68068 4)
(U.S. Army Geographic Information Systems Div., Fort Belvoir, Va.)

Abstract - This program plans to devise a man/machine interactive system for the extraction and merging of MGI terrain factor data (vegetation, soils, etc.) from multiple input data, and develop a family of equipment for use at echelons from CONUS to Army Corps to recombine and analyze terrain graphs and imagery (photography, radar, graphics, etc.). Engineering analyses and evaluations will be conducted in-house on automated image data extraction system (AIDES), which is currently being tested with multiple image inputs. This work is aimed at identifying the elements and specification that represent the optimal system. Literature will be reviewed in the field of devices suitable for image terrain data (MGI) extraction and updating and production of special purpose maps. Shortfalls and deficiencies in current methods and equipment will be identified to reduce turnaround time between military activity/event and portrayal of information in a graphic or display for analysis and planning.

SSIE

T-7

TURINETTI, J.D., and R.J. HOFFMANN, 1974, Pattern Analysis Equipment and Techniques--for Aerial Multispectral Imagery, in Photogrammetric Engineering, v. 40, Nov. 1974, pp. 1323-1330.
(USAF, Rome Air Development Center, Griffiss AFB, N.Y.)

Abstract - The development work and the investigations reported are related to the application of pattern-recognition technology in approaches designed to automate the processing and the analysis of remotely sensed data. A highly flexible interactive multispectral image processing system has been developed to provide analysis techniques for extracting characteristics features of materials as a basis for the design of an automated classification logic. The hardware/software capabilities of the system are described and the results of a preliminary system analysis are discussed.

NASA

ULABY, F.T., and J. McNAUGHTON, 1975, Classification of Physiography from ERTS Imagery, in Photogrammetric Engineering and Remote Sensing, v. 41, no. 8, Aug. 1975, pp. 1019-27.
(Kansas University Center for Research, Inc., Lawrence, Kans.)

Abstract - Discusses an investigation of the potential application of optical data processing to ERTS imagery as a means for automatic identification of large-scale ground patterns. Spatial frequency distribution and orientational information were derived from ERTS-1 imagery of Kansas for each of 80 sample areas, each 37 km in diameter. The application of classification algorithms to this data reveals that a high degree of correlation exists between the physiography of a sample area and its frequency information. Specifically, the band of frequencies between 1.1 and 2.8 cycles/km appear to contain most of the information needed in distinguishing different physiographic regions.

NASA

V-1

VAJO, V., 1976, Digital Generation of Contour Maps for Raster Scan Display, (Rept. No. ECOM-4454; AD-A034 663/5SL), 57 pp.
(Army Electronics Command, Fort Monmouth, N.J.)

Abstract - This report is concerned with the development of a digitally generated contour map to be displayed on standard raster TV for use in Army aircraft. The requirement for a display of this type is generated by the operations of army aircraft in nap-of-the-earth NOE flight during both day and night operation. NOE flight in this case refers specifically to pilotage at or below tree top level. The study proved the feasibility of generating digital contour maps for display on standard TV monitors. Computer programs were written in assembly language for the Singer SKC-2000 airborne computer which generate two color black-and-white contour maps for display on a standard 525 line television system.

DDC

VAN DE LINDT, W.J., 1977, Digital Technique for Generating Synthetic Aperture Radar Images, in IBM Journal of Research and Development, v. 21, no. 5, 1977, pp. 415-432.

Abstract - This paper describes a digital processing method applicable to a synthetic aperture radar, to be carried by the space shuttle or by satellites. The method uses an earth-fixed coordinate system in which corrective procedures are invoked to compensate for errors introduced by the satellite motion, earth curvature, and wavefront curvature. Among the compensations discussed are those of the coordinate system, skewness, roll, pitch, yaw, earth rotation, and others. The application of a Fast Fourier Transform in the numerical processing of the two-dimensional convolution is discussed in detail.

Handsearch

V-3

VANDERBRUG, G.J., 1976, Experiments in Iterative Enhancement of Linear Features--LANDSAT and Skylab Image Data Processing, in Proceedings of the Symposium on Machine Processing of Remotely Sensed Data, Purdue University, West Lafayette, Ind., Jun. 29 - Jul 1, 1976, pp. 4A-32 to 4A-44.
(Maryland University, College Park, Md.)

Author Abstract - Lines and curves in an image are detected locally by a template-matching process which determines the 'line-ness' value of the image at each point, in a set of orientations. The output of the detection process is the strongest of these values at each point, and the orientation that gave rise to this value. The results of this approach tend to be noisy, but their noisiness can be reduced by examining, for each point, the values at nearby points, in the direction defined by the preferred orientation, and increasing the point's value if the nearby points have high values and similar orientations. Iteration of this reinforcement process leads to further noise reduction. Several variations on this scheme are presented. The preferred orientations can also be 'sharpened' by examining the orientation at nearby points (in the preferred direction) and biasing it toward their average. Experimental results using these methods are obtained for LANDSAT and Skylab images containing many linear features.

NASA

VANDERBRUG, G.J., 1978, Linear Feature Detection and Mapping, Ph.D. Thesis, 263 pp. (Maryland Univ., College Park, Md.)

Abstract - The methods developed are applicable to many types of pictures, but the examples used in the dissertation are all taken from remote sensory imagery. In such imagery, roads, rivers, and geologically significant structures known as lineaments all appear as linear features. The approach taken involves several steps: (1) detection of the features on a local basis using a local matching process; (2) iterative enhancement of the local feature detection output using contextual information; (3) representation of the resulting curve segments in a data structure; and (4) merging the segments, as guided by the data structure, to yield global linear features.

NASA

V-5

VAN GENDEREN, J.L., B.F. LOCK, and P.A. VASS, 1978, Remote Sensing: Statistical Testing of Thematic Map Accuracy, in Remote Sensing of Environment, v. 7, no. 1, 1978, pp. 3-14.
(Fairey Surveys Ltd., Maidenhead, Berkshire, England; Salisbury College of Advanced Education, Adelaide, Australia)

Abstract - In order to achieve wider acceptance among users of thematic maps derived from remote sensing data, the interpreter must be able to specify the accuracy of his product. This requires a valid sampling procedure to estimate classification accuracy. Although several alternative methods have been used in the past, none provide sufficient statistical justification for the allocation of sample points in each category of land use using remote sensing imagery. This paper describes a more detailed and more reliable method for determining the most appropriate (i.e., minimum) sample size. The concept developed and described in the paper incorporates the probability of making incorrect interpretations at particular prescribed accuracy levels, for a certain number of errors, for a particular sample size. The remote sensing sampling strategy presented has the added advantage that it can easily be adapted for use with most forms of remote sensing imagery, including orbital data. It provides a reliable framework for testing the accuracy of any remote sensing image interpretation-based land use classification using the minimum number of sample points, thereby saving time and money, especially if it is employed in operational surveys where high specification accuracy levels need to be guaranteed.

Handsearch

VANWIE, P., and M. STEIN, 1976, A LANDSAT Digital Image Rectification System, (Rept. No. NASA-TM-X-71115, X-931-76-101), 13 pp.
(National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.)

Abstract - DIRS is a digital image rectification system for the geometric correction of LANDSAT multispectral scanner digital image data. DIRS removes spatial distortions from the data and brings it into conformance with the Universal Transverse Mercator (UTM) map projection. Scene data in the form of landmarks are used to drive the geometric correction algorithms. Two dimensional least squares polynominal and spacecraft attitude modeling techniques for geometric mapping are provided. Entire scenes or selected quadrilaterals may be rectified. Resampling through nearest neighbor or cubic convolution at user designated intervals is available. The output products are in the form of digital tape in band interleaved, single band or CCT format in a rotated UTM projection. The system was designed and implemented on large scale IBM 360 computers.

NTIS/NASA/ERTS-BIB/GEO-G

VINCENT, R.K., B.C. SALMON, W.W. PILLARS, and J.E. HARRIS, 1975, Surface Compositional Mapping by Spectral Ratioing of ERTS-1 MSS Data in the Wind River Basin and Range, Wyoming. Final Report, Sept 1972 - Sept 1974, (Contr. No. NAS5-21783; Rept. No. E75-10312; NASA-CR-142855; ERIM-193300-32-F), 72 pp. (Environmental Research Inst. of Michigan, Ann Arbor, Mich.)

Abstract - ERTS data collected in August and October 1972 were processed on digital and spectral purpose analog recognition computers using ratio enhancement and pattern recognition. Ratios of band-averaged laboratory reflectances of some minerals and rock types known to be in the scene compared favorably with ratios derived from the data by ratio normalization procedures. A single ratio display and density slice of the visible channels of ERTS MSS data, channel 5/channel 4 (R5,4), separated the triassic chugwater formation (redbeds) from other formations present and may have enhanced iron oxide minerals present at the surface in abundance. Comparison of data sets collected over the same area at two different times of the year by digital processing indicated that spectral variation due to environmental factors was reduced by ratioprocessing.

NASA/NTIS

VOGEL, T.C., 1977, An Analysis of LANDSAT Systems for Cartographic and Terrain Information. Technical Report Aug - Dec 76,(Rept. No. ETL-0103; AD-A044 431), 58pp.
(U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia 22060)

Abstract - The scientific and technical literature is reviewed to analyze the capabilities of LANDSAT Systems 1, 2, 3, and 4 for hydrographic, topographic, planimetric, and thematic map compilation. The systems capabilities were analyzed according to the following qualitative code for a selected list of map and chart requirements: 0 - Not detectable, the map element cannot be discerned or located from either type of LANDSAT data; 1 - Detectable, map element can be detected but not identified from the type of LANDSAT data indicated; 2 - Identifiable, map element can be detected and recognized as a particular type of feature from the LANDSAT data indicated, e.g. road, canal, etc., collateral information may be required to reach this analysis level; 3 - Classifiable, LANDSAT data, with the use of all available collateral information, can provide the information required for the map element including all required measurements, e.g. width, length, and areas. It was concluded that LANDSAT 1, 2, 3 MSS data is compatible with National Map Accuracy Standards and can be used to update the map elements on map scales 1:1,000,000 through 1:250,000, although many of the cultural, hydrographic, and botanical elements may be unclassifiable. The improved systems capabilities of LANDSAT 4 may provide a method for updating map scales 1:1,000,000 through 1:50,000. However, many of the required cultural and hydrographic map elements may remain unclassifiable even with the Thematic Mapper system.

ETL BIB

V-9

VOGEL, T.C., and E.G. TRELINSKIE, 1978, Multi-Image Interpretation Techniques Tests, (Contr. No. DA0L8107; Rept. No. ZQA128107 3)
(U.S. Army Geographic Information Systems Division, Fort Belvoir, Va.)

Abstract - This program will evaluate existing and developmental imagery sensor outputs through conventional techniques, and develop equipment and man-interactive automated techniques to extract and process essential terrain and topographic data for factor overlays, MGI, and topographic data bases. It will document the conventional techniques and use the resulting performance baseline and outputs for comparison to automated techniques developed with the ETL experimental automated image data extraction system (AIDES). Included will be in-house quantitative image interpreter tests utilizing aerial imagery acquired with conventional and non-conventional systems (multispectral and multiband images) and evaluation of the effectiveness of acquisition systems for collection of MGI terrain data. This will form the base level for input images, human interpretation and development of automated interpretation techniques for comparative analysis. Feedback from these efforts will provide the basis for identification of machine assisted processing, conceptual design of electro-optical interpretation devices, and for updates of the sensor matrix study, technical reports and draft input to Army FM and TM publications.

SSIE

WAGNER, H., and R.A. SHUCHMAN, 1977, Digital Exploitation of Synthetic Aperture Radar, in Proceedings of the 11th International Symposium on Remote Sensing of Environment, Apr. 1977, pp. 563-570. (Environmental Research Institute of Michigan, Ann Arbor, Mich.)

Abstract - Digital processing of SAR data was undertaken with an emphasis towards earth resource applications. Software was generated to solve the geometry and data collection problem unique to SAR, mainly slant range to ground range, antenna, and R^3 correction factors. The SAR data was processed using the University of Michigan School of Natural Resources LIGMALS processing system. This system was selected because it permitted easy implementation and modification of processing algorithms for use with SAR data.

GEO-G

WARREN, M.E., 1977, Target Discrimination Via Nonlinear Identification, (Contr. No. DF043540; AFOSR-2996-76; Rept. No. GQF 43540 1).
(State Univ. of Florida, School of Engineering, Gainesville, Fla.)

Abstract - Remote sensors have become an important part of the Air Force hardware inventory in the past decade. The value of the sensed information would be greatly enhanced if the sensor data could be processed so as to effectively discriminate between classes of sensed targets. The objective of this grant is to apply the nonlinear identification theory of Wiener to the problem of target discrimination. Success in the pursuit of this objective would expand Air Force capabilities in information gathering and in the development of discriminating mines of reasonable cost. Present methods rely on pattern recognition techniques and are of limited utility. The nonlinear identification approach here involves the determination of the Wiener kernals using cross correlation techniques. Fast Fourier transforms algorithms make this approach computationally feasible. It has already been demonstrated that a significant amount of information can be obtained about a nonlinear system just by determining the first several Wiener kernals. If successful, this method would provide an entirely new class of discriminants for classifying targets.

SSIE

WATANABE, M.S., 1977, Selection of Variables in Clustering and Pattern Recognition, (Contr. No. DF023010; AFOSR-2259-72; Rept. No. GQF 2162510) (Univ. of Hawaii, School of Arts and Sciences, Honolulu, Hawaii)

Abstract - There exists a low rate and reliability of processing complex phenomena such as multiple targets and reconnaissance photographs. This project hopes to improve the rate and reliability of processing complex phenomena by the development of new algorithms and techniques in pattern recognition and clustering. This research will pursue work in the following areas - (1) develop new algorithms in pattern recognition and clustering by computer. The problem of the conflict between the number of measurements and the number of sample points will be investigated in connection with the generalized likelihood function, and a new criterion will be introduced to limit the number of dimensions. (2) develop new techniques in pattern recognition by optical means. Work will continue in the development of an optimal set of filters to discriminate different alphabet letters. (3) investigate problems related to artificial and natural intelligence. Two new concepts were developed earlier -- inverse H-theroem and paradigmatic symbol. These will be combined and a new development in the theory of artificial intelligence is expected. (4) work will continue on a book on pattern recognition.

SSIE

W-4

WEBER, W.B., 1978, Some Cartographic Applications of Digital Image Processing, (Rept. No. IH 504968), 19 pp. (Institut Fuer Angewandte Geodaesie, Frankfurt-am-Main, West Germany)

Abstract - Some examples of techniques for digital image processing to be used for problems in computer-aided cartography are presented. These are: production of multi-line symbols from skeleton lines, the conformal transformation, the interactive erasure of a line part, the coding of meshes, edges, and nodes of a planar graph, and the determination of classes of terrain slopes from maps with equidistant contour lines. It is demonstrated how these complex operations can be reduced to a few macros only (i.e., thickening, propagation, calculation of the distance transform, and convolution); these macros again are to be composed of a few primitive image operations. The problems related to the large data quantities and high computing times are also dealt with.

NTIS/NASA

WECKSUNG, G.W., and J.R. BREEDLOVE, JR., 1977, Rationale of the Ratio Image in Multispectral Remote Sensing, in Digital Signal Processing Symposium, Albuquerque, N.M., Dec. 6 1977, (Contr. No. W-7405-ENG-36; Rept. No. CONF-771206-21), 13 pp.
(Univ. of California, Los Alamos Scientific Lab., Los Alamos, N. Mex.)

Abstract - A simple mathematical interpretation of the properties of ratio images derived from LANDSAT and other sources of multispectral imagery is presented. A spectral signature is defined which is well represented by ratios of pairs of spectral bands and can be related to the problem of clustering and unsupervised learning. Some practical problems arising in the generation of LANDSAT ratio images are considered, and an effective, simple method for reduction of the dynamic range of such images is presented along with digital image processing examples.

NTIS

W-6

WECKSUNG, G.W. and J.R. BREEDLOVE, JR., 1978, A Technique for Dynamic Range Reduction of LANDSAT Ratio Images, in IEEE 1978 Region 6 Conference Record "Electronics for Resources Management", Alamogordo, N. Mex., April 12-14, 1978, pp. 84-9.
(Univ. of California, Los Alamos Scientific Lab., Los Alamos, N. Mex.)

Abstract - A scheme for dynamic range reduction, based on a mathematical model of the multispectral image, is presented. It can be implemented on stand-alone digital image processing systems as well as general purpose computers. This technique also has potential application in machine classification of geological data. Digital image processing examples are presented in which this new scheme is compared with other commonly used techniques for dynamic range reduction.

INSPEC

WEST, T.R., R.L. FREDERKING, C.J. STOHR, and S.M. WOODRING, 1975, Analysis of Multispectral Data Using Computer Techniques - Pennsylvania, Kansas, Virginia, and California Test Sites, (Contr. No. DOT-FH-11-7565; Rept. No. LARS-196200-1-T-FR; PB-267 824), 39 pp. (Purdue Univ., Lab. for Applications of Remote Sensing, Lafayette, Ind.; Federal Highway Administration, Washington, D.C.)

Abstract - This report summarizes analysis of multispectral scanner data collected over FHWA test sites in Pennsylvania, Kansas, Virginia and California. Day and night time imagery collected at aircraft altitudes in discrete bands of ultraviolet through thermal infrared radiation, were analyzed using computer-assisted techniques at the Laboratory for Applications of Remote Sensing. The overall objective for the test sites studied was to develop techniques for identifying and classifying through computer applications, those surface materials which are significant to highway location and design. Specific accomplishments of the study were (1) mapping surface geology, both unconsolidated and consolidated materials - California, (2) mapping agricultural soils - Pennsylvania, (3) engineering soils mapping - Kansas, and to a lesser extent, Pennsylvania, (4) investigation of subsurface caverns - Kansas, and surface depressions - Virginia, (5) evaluating terrain effects on spectral response - California and Virginia, and to a lesser extent, Kansas.

NTIS

WESZKA, J.S., C.R. DYER, and A. ROSENFELD, 1976, A Comparative Study of Texture Measures for Terrain Classification--Photointerpretation Based on Fourier Power Spectra and Gray Level Statistics, in IEEE Transactions on Systems, Man, and Cybernetics, v. SMC-26, Apr. 1976, (Contr. No. F44620-72-C-0062), pp. 269-285. (Maryland University, College Park, Md.)

Author Abstract - Three standard approaches to automatic texture classification make use of features based on the Fourier power spectrum, on second-order gray level statistics and on first order statistics of gray level differences, respectively. Feature sets of these types, all designed analogously, were used to classify two sets of terrain samples. It was found that the Fourier features generally performed more poorly, while the other feature sets all performed comparably.

NASA/NTIS/COMP/GEO-G

WESZKA, J.S., A. ROSENFELD, 1975, Picture Processing, (Contr. No. N00014-75-C-0286; Rept. No. TR-378), 51 pp.
(Maryland University, College Park, Md.)

Abstract - This paper reviews the fundamentals of automatic picture processing and scene analysis. It discusses computer-based methods of segmenting pictures into meaningful parts; determining properties of the parts and relationships among the parts; and using this information to construct descriptions of the pictures. The material is organized by principal areas of application, including document reading, high-energy physics, cytology, radiology, and remote sensing of the environment.

DDC

W-10

WHITLEY, S.L., 1975, Low-Cost Data Analysis Systems for Processing Multispectral Scanner Data, in ITS NASA Earth Resources Survey Symposium, v. 1-B, pp. 1355-1375.
(National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, Tex.)

Author Abstract - A research-oriented data analysis system was developed which is used for evaluating complex remote sensor systems and for development of techniques for application of remotely sensed data. Some modular hardware components were developed which may be added to one's existing facilities to establish a low-cost data analysis system for processing multispectral scanner data. Software modules which are compatible with small general purpose digital computers process and analyze remote sensor data, and convert it to information needed by users. The software modules are written in Fortran IV language for ease of transfer to other computer systems. The basic hardware and software system requirements are defined for some low-cost data analysis systems consisting of an image display system, a small general purpose digital computer, and an output recording device. The hardware modules consist of a LANDSAT MSS data reformatting program; a series of spectral pattern recognition programs required to generate surface classification maps and tabular information; programs to convert computer generated maps from image space to a geographically referenced base; programs to extract data and irregularly shaped areas and to produce thematic maps of the designated areas; and programs to tabulate acreages of selected classification categories. Some off-the-shelf, inexpensive digital image display systems are described.

NASA/NTIS/GEO-G

WHITLEY, S.L., 1972, Digital Pattern Recognition Program for Multispectral Data Analysis, in ITS 4th Annual Earth Resources Program Rev., v. 1, 33 pp. (National Aeronautics and Space Administration, Mississippi Test Facility, Bay Saint Louis, Miss.)

Author Abstract - Eight areas related to pattern recognition analysis at the Earth Resources Laboratory are discussed, (1) background; (2) Earth Resources Laboratory goals; (3) software problems/limitations; (4) operational problems/limitations; (5) immediate future capabilities; (6) Earth Resources Laboratory data analysis system; (7) general program needs and recommendations; and (8) schedule and milestones.

NASA

W-12

WHITLEY, S.L., 1975, A Procedure for Automated Land Use Mapping Using Remotely Sensed Multispectral Scanner Data, (Rept. No. NASA-TR-R-434, JSC-S-406), 49 pp. (National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, Tex.)

Author Abstract - A system of processing remotely sensed multispectral scanner data by computer programs to produce color-coded land use maps for large areas is described. The procedure is explained, the software and the hardware are described, and an analogous example of the procedure is presented. Detailed descriptions of the multispectral scanners currently in use are provided together with a summary of the background of current land use mapping techniques. The data analysis system used in the procedure and the pattern recognition software used are functionally described. Current efforts by the NASA Earth Resources Laboratory to evaluate operationally a less complex and less costly system are discussed in a separate section.

NASA/NTIS/GEO-G

WIDROW, B., 1976, Pattern Analysis and Recognition by Means of Rubber Masks, (Contr. No. ENG74-21752; Rept. No. GSE 5012 1).
(Stanford Univ., School of Engineering, Palo Alto, Calif.)

Abstract - The long-range goal of the proposed research is the development of a precise, workable, and economical means for feature detection and for analysis and classification of pattern and image data. To this end, use will be made of a new and potentially powerful pattern analysis method called the "rubber mask" technique. This is a flexible template matching process in which stereotypes (templates) derived from mathematical models or from natural "training" data are formed, and then they are distorted by computer to achieve best fits to images, waveforms, or other patterns observed in a series of "unknown" data samples. The distortion parameters are useful in characterizing unknown patterns. This technique has already shown considerable promise in measuring patterns which are fuzzy, distorted, misshapen, stretched, and so on - but which in many cases appear to have some "intrinsic shape" that is maintained from sample to sample.

SSIE

WIECZOREK, U., 1976, Study About Recording and Interpretation of Change in Landscape Proved by Satellite Images by Use of an ISI-Image-Analyzer, in Proceedings of the 16th International Scientific-Technological Conference on Space, Rome, Italy, Mar. 18-20, 1976, pp. 73-84. (Muenchen Universitaet, Munich, West Germany)

Author Abstract - It is shown how with aid of an analog ISI image analyzer the change in landscape, detected by two satellite images taken at different times, can be recorded. It turned out that for the interpretation of the differences between both satellite images a detailed landscape classification and identification of individual landscape classes is necessary. In this way not only the changes could be explained but disturbing factors could be eliminated by correlation of the changes in landscape with certain landscape classes.

NASA

WILLETT, T., 1976, Algorithms and Hardware Technology for Image Recognition. Quarterly Report, 1 May - 31 Jul. 1976, (Contr. No. DAAG53-76-C-0138; Rept. No. AD-A035 027 QR-1), 72 pp.
(Westinghouse Defense and Electronic Systems Center, Computer Science Center, Baltimore, Md.)

Abstract - The report includes: definition of the automatic target cueing function; system design goals; hardware constraints; hardware implementation; threshold algorithm; parallel processing; noise region filtering; alternative hardware directions; and applicable CCD techniques and fabrication.

NASA/NTIS

WINTZ, P.A. and T.S. HUANG, 1976, Image Analysis and Modeling. Final Technical Report, 1 Nov. 74 - 31 Oct. 75, (Contr. No. F30602-75-C-0150, ARPA Order-2893; Rept. No. RADC-TR-76-76, AD-A023 633), 106 pp. (Purdue Univ., School of Electrical Engineering, Lafayette, Ind.)

Abstract - This report summarizes the results of the research program on Image Analysis and Modeling supported by the Defense Advanced Research Projects Agency. The objective is to achieve a better understanding of image structure and to use this knowledge of develop improved image models for use in image analysis and processing tasks such as information extraction, image enhancement and restoration, and coding. The ultimate objective of this research is to form a basis for the development of technology relative to military applications of machine extraction of information from aircraft and satellite imagery of the earth's surface.

DDC

WINTZ, P.A. and T.S. HUANG, 1975, Image Analysis and Modeling. Quarterly Technical Report, 1 Feb. 75 - 30 Apr. 75, (Contr. No. F30602-75-C-0150; Rept. No. AD-017 765/9ST), 195 pp.
(Purdue Univ., School of Electrical Engineering, Lafayette, Ind.; Rome Air Development Center, Griffiss AFB, N.Y.; Defense Advanced Research Projects Agency, Arlington, Va.)

Abstract - The objective of the research is to achieve a better understanding of image structure and to use this knowledge to develop improved models for use in image analysis and processing tasks such as information extraction, image enhancement and restoration, coding, etc. The ultimate objective of this research is to form a basis for the development of technology relevant to military applications of machine extraction of information from aircraft and satellite imagery of the earth's surface. This report discusses research activities during the three month period February 1 - April 30, 1975.

NTIS/DDC

W-18

WINTZ, P.A. and T.S. HUANG, 1976, Image Analysis and Modeling. Quarterly Technical Report, 1 May 75 - 31 Jul. 75, (Contr. No. F30602-75-C-0150; Rept. No. AD-A019 130; RADC-TR-75-307), 118 pp.
(Purdue Univ., School of Electrical Engineering, Lafayette, Ind.)

Abstract - The objective of this program is to achieve a better understanding of image structure and to use this knowledge to develop improved image models for use in image analysis and processing tasks such as information extraction, image enhancement and restoration, pattern recognition, image registration and coding, etc. The ultimate objective of this research is to form a basis for the development of technology related to military applications of machine extraction of information from aircraft and satellite imagery. Research efforts reported in this quarterly report include image segmentation, edge detection, image decomposition, image noise reduction, image texture classification, etc.

NASA/NTIS

WONG, K.W., 1975, Geometric and Cartographic Accuracy of ERTS-1 Imagery, in Photogrammetric Engineering and Remote Sensing, v. 41, May 1975, pp. 621-635. (Illinois University, Urbana, Ill.)

Abstract - Results are presented for a research study on the geometric and cartographic accuracy of RBV and MSS images from ERTS-1. Four frames of bulk RBV images and two frames of MSS images are analyzed using reseau images and photo-identified ground points, high-order polynomials are employed to model the distortions in the images, and the geometric fidelity and cartographic accuracy of the two systems are compared. It is shown that the geometric fidelity of the RBV system is excellent while its geographic positioning accuracy is reduced by its low resolution, and it is suggested that a different reseau pattern be developed to replace the 81-point pattern used in ERTS-1. The geometric fidelity of the MSS system is found to be considerably inferior to that of the RBV system, but use of four or more photo-identified control points can correct an image to meet the National Map Accuracy Standards for mapping at a scale of 1:5,000,000.

NASA/NTIS

W-20

WONG, R.Y., and E.L. HALL, 1978, Sequential Hierarchical Scene Matching, in IEEE Transactions on Computers, v. C-27, Apr. 1978, (Cont. No. F04702-76-C-0224, F04701-77-C-0072), pp. 359-366.
(California State Polytechnic University, Pomona, Calif.; Tennessee University, Knoxville, Tenn.)

Author Abstract - The general approach to matching two scenes by a digital computer is usually costly in computations. A match is determined by selecting the position of maximum cross correlation between the window and each possible shift position of the search region. A new approach which is logarithmically efficient is presented in this paper. Its logarithmic efficiency and computational savings will be demonstrated both theoretically and in practical examples. Experimental results are presented for matching an image region corrupted by noise and for matching images from optical and radar sensors. The significance of this approach is that scene matching can be accomplished by the use of a computer even in cases which are difficult for humans or standard correlation techniques, and can be accomplished with greatly reduced computations.

NASA

YAKIMOVSKY, Y., 1974, Boundary and Object Detection in Real World Images, (Contr. No. NAS7-100; Rept No. NASA-CR-140828, JPL-TM-33-709), 30 pp.
(California Inst. of Technology, Jet Propulsion Lab, Pasadena, Calif.)

Author Abstract - A solution to the problem of automatic location of objects in digital pictures by computer is presented. A self-scaling local edge detector which can be applied in parallel on a picture is described. Clustering algorithms and boundary following algorithms which are sequential in nature process the edge data to locate images of objects.

NTIS/NASA

YASUDA, Y., and Y. EMORI, 1974, Computer Recognition of Aerial Multispectral Photography Using Optical Density of Object, in Proceedings of the 9th International Symposium on Remote Sensing of the Environment, Ann Arbor, Mich., Apr. 15-19, 1974, pp. 91-101.
(Chiba University, Chiba, Japan)

Author Abstract - In order to maintain uniform performance in computer recognition of aerial multispectral photography, a simple calibration technique of atmospheric effects, exposure conditions and film processing conditions is studied based on a concept of photographic photometry. Together with a grey step-wedge on the ground, the objects are photographed by a 4-band multispectral camera. From the wedge density data, an overall radiant energy transfer function of the system and the effects of atmospheric scattering can graphically be obtained for each multispectral band. Then, the scanning density data of the image on the film are fed into a computer and converted into the reflection density data through the overall radiant energy transfer function of the system, and a computer recognition is carried out using the reflection density data. Although the same discrimination functions were used, the computer recognitions of two imageries of different atmospheric condition and different altitude gave similar performances of classification of crop species.

NASA

ZANON, A., M. GILLOTTE, and M. ZORACKI, 1976, Spectral Analysis. Final Technical Report, Jun. 1973 - Jan. 1975, (Contr. No. F30602-73-C-0383; Rept. No. AD-A024 209; PAR-75-9), 299 pp.
(Pattern Analysis and Recognition Corp., Rome, N.Y.; Rome Air Development Center, Griffiss AFB, N.Y.)

Abstract - This report investigates the application of digital image processing techniques to a selected set of multispectral images. Various processes for performing automatic classification on selected terrain classes on 9-lens multispectral imagery were tested.

NASA/NTIS

ZIMAN, Y.L. and V.F. BARATOVA, 1975, Computerizing the Conversion of Photographs to a Specified Cartographic Projection, in Geodesy, Mapping and Photogrammetry, v. 17, no. 1, 1975, pp. 11-16. (Geodeziya i Kartografiya, no. 6, 1975, pp. 38-46, USSR)

Abstract - Broad vistas for the automation of photogrammetric and cartographic work have been unlocked by the development of digital computers. Computers are being used successfully in the adjustment of phototriangulation networks. No less important is the solution of problems of automating topographic, special, and photographic mapping. This requires the compilation of algorithms for photogrammetric processing, decoding, and cartographic interpretation of photographs, as well as equipping computers with devices for image input and output. The present paper examines the procedure and algorithm for the stepwise conversion of photograph elements to a given cartographic projection. The singularity of the proposed solution consists in that, first, the photograph is converted to any projection immediately, without requiring an intermediate photoplan, and second, the conversion involves identification of all the elements of a given photographic map representing each of the elements of the original photograph. Such an identification makes it possible to obtain photographic maps without gaps or discontinuities of representation.

Handsearch

ZOBRIST, G.W., 1976, On Clustering of ERTS Data to Develop a Character Map, in Proceedings of the IEEE Milwaukee Symposium on Automatic Computation and Control, pp. 205-10.
(Univ. of South Florida, Tampa, Fla.)

Abstract - ISODATA is a digital computer program for analyzing large quantities of data to determine clusters. The recognition system adjusts itself without external information concerning the labelling of any of the samples. This program was used to develop a character map of the NASA shuttle runway at Kennedy Space Center, Florida. The data was obtained from an ERTS satellite which transmits four dimensional wavelength data. Each spatial coordinate is approximately one acre in size. The Karhunen-Loeve transformation was used to reduce the number of dimensions used by the ISODATA clustering algorithm.

NASA

Z-4

ZUCKER, S.W., A. ROSENFELD, and L.S. DAVIS, 1975, Picture Segmentation by Texture Discrimination, in IEEE Transactions on Computers, vol. C24, no. 12, pp. 1228-1233.

Abstract - This correspondence describes a method of dividing a picture into differently textured regions by thresholding the values of a suitable local picture property. The approach used is a generalization to natural textures of a technique recently proposed by Tsuji. The examples given involve textures that differ in coarseness; a method of estimating texture coarseness by analysis of local property values is also described.

GEO-G

4. COLLECTIONS

The following entries are comprised of books, texts, and collected papers representing significant work on remote sensing and automatic feature extraction.

Since the different work of many researchers are represented within these collections, they are not indexed as to author or category. The abstract for each collection entry is intended to give the user a general idea as to the content of the volume.

BALASUBRAMANIAN, N. and R.D. LEIGHTY, 1974, Coherent Optics in Mapping, Proceedings of the Tutorial Seminar and Technology Utilization Program, Rochester, N.Y., Mar. 27-29, 1974, 305 pp.
(Univ. of Rochester, Rochester, N.Y.; Army Engineer Topographic Labs., Fort Belvoir, Va.)

Abstract - Studies are presented which deal with the fundamental concepts of coherent optics and photogrammetry and the combination of coherent optics technology with photogrammetric mapping techniques. Some of the topics covered include: photogrammetric and reconnaissance applications of coherent optics, holographic moving map display, the mensuration and mapping of holograms and holographic stereomodels, terrain measurement from holographic stereograms, a system for photogrammetric data reduction using coherent optics, and cloud screening from aerial photography applying coherent optical pattern recognition techniques.

NASA

BARRETT, E.C. and L.F. CURTIS, eds., Environmental Remote Sensing: Applications and Achievements; England: Edward Arnold Ltd.; U.S.: Crane, Russak & Co., Inc.; 1974, 300+ pp. In Remote Sensing of Environment, v. 3, no. 2, 1974 (book review).

Abstract - In the over 300 pages are printed fifteen papers which were presented at the Bristol Symposium of October 2, 1972. The papers are placed in three groups. First are those on Rocks, Soils, and Landforms. Second are five papers grouped under Land Use, Vegetation, and Crops. Third is a group entitled Water, Weather, and Climate. Relatively conventional black-and-white and color photography is the basis of most of the papers, although side-looking radar, infrared color photography, infrared line-scanner images and infrared satellite sensor outputs are also involved in several works. The papers span an extraordinary range of topics but they do it well. The referenced literature is broad and results of remote sensing research done in several countries are presented. The material is sometimes tutorial, occasionally controversial, often with tentative results. It affords a unique view of remote sensing as perceived and practiced in the United Kingdom.

Handsearch

BARRETT, E.C. and L.F. CURTIS, eds., Environmental Remote Sensing 2: Practices and Problems, London: Edward Arnold Ltd., 1977, 314 pp.; in Photogrammetric Record, v. 9, no. 51, Apr. 1978, pp. 445-446 (book review).

Abstract - This book brings together the papers which were presented at the Second Bristol Symposium on Remote Sensing held in October 1974. The papers have been grouped into three parts, the new groups being policy making for remote sensing, the processing and presentation of remote sensing data, and in situ observation and the interpretation of remote sensing data. After an introduction that deals briefly with the history and present state of remote sensing as well as the British Symposia organization, Part I includes a brief review of available sensors, papers detailing the constraints and problems in remote sensing engineering, the national program of the United Kingdom, the potential of remote sensing from Spacelab and some legal aspects raised by remote sensing from satellites. Part II includes a brief review of the cartographic uses of remote sensing, and papers on analytic methods of dealing with data using densitometric, optical Fourier transform, and computer analyses. The final part includes two papers on obtaining ground information needed for use with satellite and rocket derived data, and a paper on surface oceanographic data. LANDSAT imagery is assessed for its use as a base map in natural resource surveys and the final paper deals with the problems of analyzing and interpreting meteorological data from satellites.

Handsearch

BAUMANN, L.S., 1977, Image Understanding, Proceedings of the 5th Image Understanding Workshop, Apr. 20, 1977, Minneapolis, Minn., (Contr. No. F30602-76-C-0165; Rept. No. AD-A052 900, SAI-78-549-WA), 120 pp. (Science Applications Inc., Arlington, Va.)

Abstract - The Image Understanding Program is planned to be a five year research effort to develop the technology required for automatic and semiautomatic interpretation and analysis of military photographs and related images. This program, now in its second year of Defense Advanced Research Projects Agency (DARPA) sponsorship, was initially funded in 1976. Papers are submitted by various research personnel working on projects in the Image Understanding Program. The status of each of the diverse projects, including future research plans and goals, were workshop agenda objectives. By stimulating cross-fertilization discussions, it was hoped to assist community-wide understanding of the individual research efforts. Since the participants included personnel from the military research and development community, as well as from interested user organizations, the workshop served as a means to provide a 'dialogue' between researcher and user.

DDC

BAUMANN, L.S., 1977, Image Understanding, Proceedings of the 6th Image Understanding Workshop, Oct. 20-21, 1977, Palo Alto, Calif., (Rept. No. AD-A052 901, SAI-78-656-WA), 155 pp.
(Science Applications Inc., Arlington, Va.)

Abstract - The second year was completed of a planned five year research effort to develop the technology required for automatic and semiautomatic interpretation and analysis of military photographs and related images. The Information Processing Techniques Office (IPTO) manages this major Defense Advanced Research Projects Agency (DARPA) research program. Semi-annual workshops have been held to provide cross-fertilization of research findings among the activities working on the program and to keep the operational user community in close contact with the research community. Through these workshops, the end users can provide guidance on the requirements and the researchers can keep the users apprised of progress and problems encountered. Papers are submitted by various research personnel engaged in the overall program, including brief outlines of the progress reports as detailed by the principal investigators.

DDC

CANADIAN REMOTE SENSING SOCIETY, 1977, Proceedings of the 4th Canadian Symposium on Remote Sensing, Quebec, Canada, May 16-18, 1977, 626 pp.
(The Canadian Remote Sensing Society; Department of Fisheries and the Environment, Canada; Canada Center for Remote Sensing; L'Association Quebecoise de Teledetection; Canada Institute of Surveying, Ottawa; Canadian Aeronautics and Space Institute)

Abstract - Primary applications of remote sensing technology are discussed, including agronomy, agriculture, and cartography. Attention is given to the machine-assisted classification of remote sensing data with reference to biophysical mapping and forest-land classification. Applications of satellite imagery to hydrology are outlined along with techniques for thermal infrared imagery (noting ground surfaces covered with vegetation, sea and ice mapping, and building heat-loss). Various world-wide LANDSAT applications are discussed and processes for the interpretation of microwave data are outlined. Multispectral studies utilizing remote sensing data are described including the geological reconnaissance of dam sites, the measurement of the vertical distribution of phytoplankton in sea-water, and the remote sensing of chlorophyll. Procedures for making geometric and radiometric adjustments are presented.

NASA

CRAMER, S.D. JR. et al, 1975, Proceedings of the 35th Annual Meeting of the American Congress on Surveying and Mapping, Washington, D.C., Mar. 9-14, 1975, 276 pp. (American Congress on Surveying and Mapping, Washington, D.C.)

Abstract - Proceedings include 48 papers that deal, among other things, with the technologies of remote sensing of the environment, use of various methods of surveying and mapping for property survey, production of survey graphics, geophysical mapping, surveying organizations and training programs, and mapping by computer graphics.

EIX

DELLWIG, L.F., B.C. HANSON, N.E. HARDY, P.L. HULEN, J.R. MCCAULEY, and R.K. MOORE, 1975, Use of Radar Images in Terrain Analysis: An Annotated Bibliography, (Rept. No. ETL-0024, AD-A020 598). (Army Engineer Topographic Laboratories, Fort Belvoir, Va.; Univ. of Kansas Center for Research, Inc., Lawrence, Kans.)

Author Abstract - An annotated bibliography of articles, papers and reports dealing with the application of imaging radar systems to the geosciences has been prepared to meet the needs of both the potential user of radar imagery and the researcher in the field of tactical terrain analysis. The principles of imaging radars are described in an introductory section. Following are bibliographic entries for those pertinent publications produced up to May 1975. The author's own abstract has been reproduced or summaries have been prepared by the reviewer. Comments of the reviewers are sometimes included in order to point out publications of major importance, to underscore significant conclusions and to expose unfounded conclusions. When actual radar imagery has been used in a publication, the location and data of the imagery as well as the system which acquired it are noted in the bibliographic entry. An extensive cross-reference index aids in identifying papers pertinent to any geoscience discipline, system parameter evaluation, or imaging radar system.

NTIS

EUROPEAN SPACE RESEARCH ORGANIZATION, 1972, Data Representation Study -- GEOS Satellites. Final Report, (Rept. No. ESRO-CR(P)-282, ESOC-38/71/AR), 52 pp. (Logica, Ltd., London, England)

Abstract - Large data masses which have to be scanned quickly for significant events, and smaller sets of data for detailed investigations are two areas of data representation discussed. It is concluded that visual methods of data presentation are preferable to aural methods; suitable display hardware is available, and the design and development of suitable software are the most critical factors in the implementation of a data laboratory system. Working papers on these topics are described and bibliographic technical references are included.

NTIS/NASA

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC., 1976, Symposium on Machine Processing of Remotely Sensed Data, Purdue Univ., West Lafayette, Ind., Jun. 29-Jul. 1, 1976, 339 pp. (Institute of Electrical and Electronics Engineers, Inc., New York, N.Y.)

Abstract - Papers are presented on the applicability of LANDSAT data to water management and control needs, IBIS, a geographic information system based on digital image processing and image raster datatype, and the image data access method (IDAM) for the earth resources interactive processing system. Attention is also given to the prototype classification and mensuration system (PROCAMS) applied to agricultural data, the use of LANDSAT for water quality monitoring in North Carolina, and the analysis of geophysical remote sensing data using multivariate pattern recognition. The Illinois crop-acreage estimation experiment, the Pacific Northwest resources inventory demonstration, and the effects of spatial misregistration on multispectral recognition are also considered.

NASA

KIRSH, R.A., ed., 1978, Emerging Patterns in AIPR: Proceedings of the 8th Annual Automatic Imagery Pattern Recognition Symposium, Gaithersburg, Md., Apr. 3-4, 1978, 237 pp.
(Electronics Industries Association; National Bureau of Standards, Washington, D.C.)

Abstract - The conference was held to acquaint potential beneficiaries of pattern recognition technology with the capabilities of automatic imagery systems. Applications considered include industrial inspection, visual prostheses for the blind, automatic counting of alpha-tracks in autoradiographs, study of aggregates in concrete and bituminous mixtures, process control in the paper industry, chemical particulate pattern recognition, detection of selected cloud imagery, and the reading of stamped characters. Other topics include a spatial clustering algorithm, a digital registration system for geometric quality assessment of LANDSAT imagery, pattern recognition and data base management, and evaluation of classification rules for imagery recognition.

NASA

LINTZ, J., JR. and D.S. SIMONETT, eds., 1976, Remote Sensing of Environment, 694 pp.
(Univ. of Nevada, McKay School of Mines, Reno, Nev.; Univ. of California, Dept. of Geography, Calif.)

No abstract available.

GEOREF

MCGILLEM, C.D., ed., 1975, Proceedings of the 2nd Symposium on Machine Processing of Remotely Sensed Data, Purdue Univ., West Lafayette, Ind., Jun. 3-5, 1975, 351 pp. (Institute of Electrical and Electronics Engineers, Inc., New York, N.Y.)

Abstract - Papers are presented on computer analysis techniques for forest and agricultural applications, water resources data processing, the monitoring and evaluation of natural resources, and the analysis of land use and geological imagery. Also discussed are analysis algorithms, clustering and feature selection, image processing and pattern recognition techniques. Emphasis throughout is on satellite data, with particular emphasis on LANDSAT multispectral band scanner imagery.

NASA

MICHAEL, G., ed., 1975, Proceedings of the Seminar on Acquisition and Analysis of Pictorial Data: The Modern Science of Imagery, San Diego, Calif., Aug. 19-20, 1974, 111 pp.
(Univ. of California, Livermore, Calif.)

Abstract - Papers are presented which examine the general principles of techniques for acquiring the characteristics of images and for processing and reconstruction of images. Image processing equipment and software are described, and special attention is given to processing and display with synthetic holograms. Some of the topics covered include an overview of sensitometry and densitometry for the macro and micro conditions, computer image processing, digital restoration of the audio and video signals, digital image processing with pseudo-color, self-calibration and analysis of image formation in the sub-nanosecond domain, shaping wavefronts for map transformations, and the modulated grating hologram.

NASA

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, 1975, NASA Earth Resources Survey Symposium: the 1st Comprehensive Symposium on the Practical Application of Earth Resources Survey Data, (Rept. No. NASA-TM-X-58168, JSC-09930), 3 volumes.
(National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, Tex.)

Abstract - A symposium was conducted on the practical applications of earth resources survey technology including utilization and results of data from programs involving LANDSAT, the Skylab earth resources experiment package, and aircraft. Topics discussed include: geological structure, landform surveys, energy and extractive resources, environmental monitoring and management, multispectral band scanners, mapping, and information systems and services.

NTIS/NASA/ERTS-BIB

NIGRO, V.A. and L. PICCOLOMINI, 1973, Data Preprocessing Systems for Earth Resources Surveys. Volume 5, Bibliography, (Rept. No. ESRO-CR-299, ESTEC-1761/72), 134 pp.
(European Space Resource Organization (ESRO), Paris, France)

Abstract - The bibliography was compiled with the aim of providing an updated and thorough collection of pertinent literature in the field of image processing and related topics. It is divided into the following areas: image analysis, coding, transmission, enhancement, restoration, and detection.

NTIS/NASA

NUWER, JOHN E., et al, 1973, Proceedings of the Conference on Machine Processing of Remotely Sensed Data, Purdue Univ., West Lafayette, Ind., Oct. 16-18, 1973, 438 pp. (Institute of Electrical and Electronics Engineers, Inc., New York, N.Y.)

Abstract - Topics discussed include the management and processing of earth resources information, special-purpose processors for the machine processing of remotely sensed data, digital image registration by a mathematical programming technique, the use of remote-sensor data in land classification (in particular, the use of ERTS-1 multispectral scanning data), the use of remote-sensor data in geometrical transformations and mapping, earth resource measurement with the aid of ERTS-1 multispectral scanning data, the use of remote-sensor data in the classification of turbidity levels in coastal zones and in the identification of ecological anomalies, the problem of feature selection and the classification of objects in multispectral images, the estimation of proportions of certain categories of objects, and a number of special systems and techniques.

NASA/COMP

AD-A076 148 LOGICAL TECHNICAL SERVICES CORP VIENNA VA F/G 14/5
AUTOMATIC FEATURE EXTRACTION: AN ANNOTATED BIBLIOGRAPHY.(U)
MAY 79 DAAK70-78-C-0195
UNCLASSIFIED ETL-0189 NL

5 OF 5
AD
A076148

END
DATE
FILMED
11-79
DDC

POLS, L.C.W., 1977, Survey On Ongoing Pattern Recognition Research Projects in the Netherlands, (Rept. No. HC A02/MF A01, DCAF E002629, IZF-1977-3, TDCK-69056), 19 pp.
(Institute for Perception RVO-TNO, Soesterberg, Netherlands)

Abstract - The projects are listed according to the RSG-4 classification scheme. This documentation has also been presented to the NATO AC/243 (panel 3) Research Study Group (RSG) 4 on pattern recognition, a group surveying pattern recognition projects in the NATO member states. The papers are written partly in Dutch and partly in English.

NTIS/NASA

PRATT, W.K., 1974, Image Processing Research. Technical Semi-Annual Report, 1 Mar. - 31 Aug. 1974, (Contr. No. F08606-72-C-0008; Rept. No. AD-786 176, USCIPI-540. See also Rept. No. AD-779 332), 130 pp. (Univ. of Southern California, Image Processing Institute, Los Angeles, Calif.)

Modified Author Abstract - The analysis and development of techniques and systems are presented for efficiently generating, processing, transmitting and displaying visual images and two-dimensional data arrays. Research is oriented toward digital processing and transmission systems. Five task areas are Image Coding Projects: the investigation of digital bandwidth reduction coding methods; Image Restoration and Enhancement: the improvement of image fidelity and presentation format; Image Data Extraction Projects: the recognition of objects within pictures and quantitative measurement of image features; Image Analysis Projects: the development of quantitative measures of image quality and analytic representation, and Image Processing Support Projects: development of image processing hardware and software support systems.

DDC

ROSENFELD, A., 1978, Picture Processing, 1977, in Computer Graphics and Image Processing, v. 7, no. 2, 1978, pp. 211-242.

Author Abstract - This paper presents a bibliography of over 600 references related to the computer processing of pictorial information, arranged by subject matter. Coverage is restricted, for the most part, to a selected set of U.S. journals and proceedings of specialized meetings. The topics covered include digitization, compression, and approximation; transforms and filtering; enhancement, restoration, and reconstruction; hardware and software; pictorial pattern recognition; matching and local feature detection; segmentation and scene analysis; pattern and shape; and formal models.

GEO-G

SHAHROKHI, F., ed., 1975, Remote Sensing of Earth Resources. Volume 4, in Proceedings of the 4th Annual Conference on Earth Resources, Tullahoma, Tenn., Mar. 24-26, 1975, 824 pp.
(Univ. of Tennessee, Tullahoma, Tenn.)

Abstract - The geomorphic interpretation of SKYLAB photography collected over the Nevada portion of the Great Basin, the use of infrared imagery in the selection of a port facility in Western Australia, the application of LANDSAT to rangeland management, to a wetlands inventory of Nebraska, to soil mapping of Northwestern India and to snow and vegetation classification are considered. Also examined are the use of remote sensors for the early detection of Dutch Elm disease, for the detection of Gypsy moth damage, for air and water pollution measurements, for thermal pollution monitoring, for ground water prospecting in Tennessee, for sediment mapping and for determining Kansas water quality. Attention is also paid to the application of information theory to remote sensing, the organization of a computer-based integrated resource inventory, mapping and assessment system based on LANDSAT data, the description of a German program for aerial remote sensing, a computer-based remote sensing literature cataloging system and the digital correction of LANDSAT multispectral scanner bulk data for high resolution image data base.

NASA

STAFFORD, D.B., R.O. BRUNO and H.M. GOLDSTEIN, 1973, An Annotated Bibliography of Aerial Remote Sensing in Coastal Engineering, (Rept. No. CERC-MP-2-73, AD-766 720), 131 pp.
(Army Coastal Engineering Research Center, Washington, D.C.)

Author Abstract - A bibliography is presented of representative literature covering the applications of aerial remote sensing techniques to coastal engineering. About 200 references published since 1934 are presented. Annotations accompany each bibliographic entry and are a concise and informative summary of the references describing the characteristics of each remote sensor in coastal engineering investigations. Computer indexes of authors, titles and keywords are included.
Portions of this document are not fully legible.

DDC

STEINER, D. and A.E. SALERNO, 1975, Remote Sensor Data Systems, Processing and Management, in Manual of Remote Sensing, Vol. I, pp. 611-803. (American Society of Photogrammetry, Falls Church, Va.)

Abstract - The report discusses information systems, image data transmission, encoding and decoding, storage and retrieval; image data input and output, image processing principles and implementation, and pattern recognition. An extensive bibliography is provided.

GEO-G

STEWART, R.K., F.F. SABINS, JR., L.C. ROWAN and N.M. SHORT, 1976, Geology, (Rept. No. ND052615), 8 pp. (?) (U.S. Geological Survey, Reston, Va.; Goddard Space Flight Center, Greenbelt, Md.; Chevron Oil Field Res. Co.)

Abstract - Papers from private industry reporting applications of remote sensing to oil and gas exploration were presented. Digitally processed LANDSAT images were successfully employed in several geologic interpretations. A growing interest in digital image processing among the geologic user community was shown. The papers covered a wide geographic range and a wide technical and application range. Topics included: oil and gas exploration, by use of radar and multisensor studies as well as by use of LANDSAT imagery or LANDSAT digital data; mineral exploration, by mapping from LANDSAT and SKYLAB imagery and by LANDSAT digital processing; geothermal energy studies with SKYLAB imagery; environmental and engineering geology, by use of radar or LANDSAT and SKYLAB imagery; regional mapping and interpretation; and digital and spectral methods.

NASA

THOMAS, J.O. and P.G. DAVEY, 1977, Proceedings of the British Pattern Recognition Association and Remote Sensing Society Joint Meeting on Texture Analysis, Oxford, England, April 19, 1977, 135 pp.

Abstract - These proceedings consist of 6 invited papers. They are a mixture of academic and practical aspects of current work in the U.K., and of industrial and university research contributions.

GEO-G

UNIVERSITY OF ARIZONA, 1973, Proceedings of the 4th Annual Conference on Remote Sensing in Arid Lands, Tuscon, Ariz., Nov. 1973, 374 pp.
(Univ. of Arizona, Tuscon, Ariz.)

Abstract - The proceedings include 37 papers. The annual conference was designed to bring together scientists whose remote sensing applications focus on the arid areas of the world and related problems such as land use, environmental monitoring, agriculture, forestry, range, mineral and water resources. Proceedings of the 1974 conference are out of print.

COMP

VAN GENDEREN, J.L. and W.G. COLLINS, 1975, Remote Sensing Data Processing, 145 pp.
(Sheffield University, Sheffield, England; Aston University, Birmingham, England)

Abstract - Papers are presented on the use of photographic materials in remote sensing, the visual interpretation of remote sensing data and electronic image enhancement techniques, and a nonmathematical account of automated processing of remote sensor data. Also considered are supervised and unsupervised pattern classification of agricultural areas and noncultivated natural terrain, digital processing for side-looking airborne radar, and a system for scanning remote sensor data when recorded on photographic emulsions.

NASA

CATEGORY INDEX

ANALOG

C-8
H-4 H-5
M-16

DIGITAL

A-4 A-6 A-7 A-10 A-11
B-1 B-2 B-3 B-4 B-6 B-8 B-10 B-12 B-16 B-18
B-19 B-27 B-28 B-29 B-30 B-31 B-32 B-37 B-38
C-1 C-4 C-5 C-14 C-16
D-1 D-2 D-4 D-8 D-9 D-13 D-14
E-4
F-4 F-7
G-4
H-2 H-3 H-7 H-8 H-9 H-10 H-20 H-21 H-25 H-26
H-28 H-32 H-35
J-1 J-1a J-2
K-3 K-7 K-8 K-10 K-16 K-17 K-18
L-4 L-5 L-6 L-7 L-8 L-10 L-22 L-23 L-24 L-25
M-6 M-10 M-13 M-15 M-17
N-1 N-3 N-6
P-9
R-2 R-14 R-24
S-4 S-5 S-12 S-22 S-23 S-27 S-28 S-29
T-6
W-4 W-7 W-16 W-17

HYBRID

A-17
B-13 B-20 B-21 B-22 B-23 B-24 B-34 B-35 B-36
C-3 C-7
D-12

G-7

H-1 H-6 H-11 H-12 H-14 H-27 H-29 H-34

I-1

J-4

K-1

L-1 L-12 L-18 L-28

R-5 R-6

S-1 S-13

V-7

OPTICAL

B-7 B-7a B-25 B-26

C-6 C-10 C-15

D-3 D-7

H-13 H-15 H-16 H-18 H-19 H-22 H-23 H-24 H-30 H-36

K-4 K-5 K-6 K-11 K-13

L-9 L-11 L-16 L-19 L-26

Mc-4

M-2 M-7

N-7

R-22

S-17

V-9

Y-2

MISCELLANEOUS

General

A-1 A-2 A-5 A-20

B-5 B-33 B-39

C-9 C-11 C-12 C-13

D-5 D-6 D-15 D-17

E-2

G-2 G-6

H-17 H-38

K-2 K-12 K-14 K-15
L-2 L-3 L-15 L-20 L-21
Mc-1 Mc-2 Mc-3
M-1 M-3 M-5 M-9 M-12
N-4 N-5
O-1
P-10
R-1 R-9 R-10 R-12 R-19 R-20 R-21
S-7 S-8 S-10 S-14 S-15 S-16 S-18 S-19 S-20
S-21 S-24 S-30
T-1 T-2 T-5
V-4 V-5 V-8
W-8 W-9 W-11 W-15
Z-4

Analog

W-14

Digital

A-8 A-9 A-12 A-13 A-14 A-15 A-16 A-18 A-19
B-9 B-15
C-2 C-17
D-10 C-11 D-16
E-3 E-5 E-6
F-1 F-5 F-6
G-1 G-3 G-5
H-31
J-5
K-9
M-4 M-11 M-14
N-2 N-8
O-2 O-3
P-1 P-2 P-3 P-4 P-5 P-6 P-7
Q-1 Q-2

R-3 R-4 R-8 R-11 R-13 R-15 R-16 R-17
S-6 S-9
T-3 T-4
V-1 V-2 V-6
W-1 W-5 W-6 W-10 W-12 W-18 W-19 W-20
Y-1
Z-1 Z-2 Z-3

Hybrid

A-2a A-3
B-11
F-3
H-33 H-39
M-8
R-7 R-18
S-31
W-2 W-13

Optical

B-14
E-1
F-2
H-37
J-3
L-13 L-14 L-17 L-27
P-8
R-23
S-2 S-3 S-11 S-25 S-26
T-7
U-1
V-3
W-3

PERSONAL AUTHOR INDEX

AUTHOR	INDEX NUMBERS
Abbe, W. W.	M-16
Abrams, M. J.	G-2
Adrien, P.-M.	A-1
Aepli, T.	A-2
Aggarwall, A. S.	S-12
Aggarwall, J. K.	A-2a, A-3, A-4, M-3
Agrawala, A. K.	A-5
Albuquerque, E. J.	A-6
Algazi, R.	A-7
Anderson, D. E.	A-8, H-8
Anderson, J. M.	N-1
Andresen, K. W.	A-9
Andrews, H. C.	A-10
Andrus, J. F.	A-11
Angelici, G. L.	A-12
Anuta, P. E.	A-14, A-15, A-16, H-27
Arguello, R. J.	A-17
Armstrong, A. C.	A-18
Ashbaugh, J. G.	A-19
Atkinson, R. J.	A-20
Babcock, H. C.	B-1
Bagwell, C.	D-16
Bajcsy, R.	B-2, B-3, B-4
Bajczak, D.	B-5
Baker, V. R.	B-6
Balasubramanian, N.	B-7, B-7a
Baldridge, P. E.	B-8
Ball, D. L.	K-3
Baratova, V. F.	Z-2
Barnea, D. I.	B-9
Barrow, H. G.	B-10
Bartlett, D.	K-14
Basu, J. P.	K-3
Batson, R. M.	B-11
Baumgardner, M. F.	B-12, K-16
Bayma, R. W.	B-13
Beaumont, T. E.	B-14
Beaven, P. J.	B-14

Benton, J. R.	B-15
Benton, W. D.	R-24
Berkebile, J. S.	F-3
Bernstein, R.	B-16, B-17, M-14, S-4
Biehl, L. L.	B-18
Billingsley, F. C.	G-3
Bissell, J. D.	H-9
Bitler, J. R.	B-19
Blodget, H. W.	B-20
Bodechtel, J.	B-21, B-22
Bodenheimer, R. E.	B-23
Boerner, W. M.	D-4
Boettcher, A. J.	B-24
Bond, A. D.	B-25, B-26
Bondurant, R. A.	L-14
Bonrud, L. O.	B-27, B-28
Borden, F. Y.	Mc-3
Bosley, R. J.	H-10
Bosman, E. R.	B-29, B-30
Boston, S.	B-31
Boyell, R. L.	B-32
Bozek, R. E.	L-21
Bradatsch, H.	L-13
Brain, A. E.	H-3
Breeding, K. J.	B-33
Breedlove, J. R., Jr.	W-5, W-6
Bressanin, G.	B-34, B-35
Brimblecombe, P.	A-18
Brinley, W. R., Jr.	L-20
Brooke, R. K., Jr.	B-36
Brooks, J.	A-2
Bryant, N. A.	A-12, B-37, B-38
Bryant, W. F.	H-11
Buckmeier, F. J.	B-39
Cambou, F.	R-5, R-6
Camillerapp, J.	C-1
Campbell, C. W.	A-11
Cannon, M. W., Jr.	C-2, C-3
Carafides, A.	A-2
Carl, J. W.	C-3
Carter, V.	C-4
Chadwick, T.	S-12
Chen, C. H.	C-6, C-7
Chen, P.-F.	C-8
Chiu, H.-Y.	C-9

Clark, B. B.	S-4
Clark, R. A.	C-10
Clerici, E.	B-29, B-30
Collins, W.	C-9
Colp, J. L.	B-39
Colvocoresses, A. P.	C-11
Considine, P. S.	B-7a
Conti, R.	C-12
Cook, J. J.	C-13
Cooper, M. T.	C-14
Cosentino, M. J.	D-5
Crane, R. B.	C-15
Crawford, W. L.	C-16
Cullen, L. E.	R-24
Cummings, R. E.	S-25, S-27
Cunningham, R. A.	S-3
Currier, P.	C-17
Currin, T. R.	R-10
Dallam, W.	A-2
Dalton, C. C.	D-1
Dalton, J. T.	D-2
Dangermond, J. P.	N-5
Danis, N. J.	D-3
Das, Y.	D-4
Dasarathy, B. V.	A-20
Daus, S. J.	D-5
David, D. J.	D-6
Davis, B. J.	D-7
Davis, L. S.	Z-4
Davis, W. A.	D-8, D-9
Decell, H. P., Jr.	D-10
Defigueiredo, R. J.	D-11
Depew, R. C.	M-14
Deries, J.	D-6
Dewar, R. E.	R-24
Dezur, R.	H-20
Dinstein, I. H.	D-12, D-13, H-12, H-13
Donker, N. H. W.	D-14
Donovan, W. E.	R-1
Dowling, J. W.	B-14
Dowman, I. J.	D-15
Downs, S. W., Jr.	D-16
Duda, R. O.	A-4
Dunn, L. M.	D-17
Dyer, C. R.	W-8

Ebersole, J. F.	E-1
Eckhart, D.	B-29, B-30
Edson, D. T.	E-2
Edwards, K.	B-11
Ehlen, J.	R-10
Eidenshink, J. C.	T-2
Eliason, E. M.	B-11
Ellefsen, R.	E-3, E-4, E-5
Ellentuck, E.	R-21
Elliott, D. A.	R-24
Elschlager, R. A.	F-2
Elston, D. P.	G-2
Emori, Y.	Y-2
Endlich, R. M.	H-3
Enstrom, K. W.	B-27
Eppler, W. G.	E-6
Erikson, J.	B-35
Faller, K. H.	F-1
Farrell, W., Jr.	R-24
Feinleib, J.	N-7
Feng, F. H.	F-5
Finding, S.	L-13
Fischler, M. A.	F-2
Fleming, M. D.	F-3
Forrest, J.	B-39
Forsen, G. E.	F-4, F-5
Frederking, R. L.	F-6, W-7
Freeman, H.	F-7
Frei, W.	H-5
Fu, K.-S.	H-35
Galloway, M. M.	G-1
Garvey, T. D.	T-1
Gaydos, L.	E-5
Giddings, L.	B-31
Gillespie, A. R.	G-2
Gillooly, R. P.	K-11
Gillotte, M. J., Jr.	F-4, F-5, Z-1
Goel, D.	D-13
Goetz, A. F. H.	G-2, G-3
Goodenough, D.	S-8
Goodrick, F. E.	L-6
Gorny, A. J.	G-4
Gourinard, Y.	R-5, R-6
Grabau, W. E.	S-24

Graham, M. H.	G-5
Gramenopoulos, N.	G-6, H-31, H-32
Green, W. L.	B-23
Greer, M. O.	R-23
Grubis, A. J.	D-3
Guess, R. R.	C-16
Gupta, J. N.	G-7
Guseman, L. F., Jr.	D-10
Haefner, H.	H-1
Halajian, J.	H-2
Hall, D. J.	H-3
Hall, E. L.	H-4, H-5, W-20
Hallock, H.	H-2
Hand, C. G.	S-27
Hannah, M. J.	Q-2
Haralick, R. M.	B-24, D-13, H-6, H-7, H-8, H-9, H-10, H-11, H-12, H-13, H-14
Harker, G. R.	H-15
Harris, J. E.	V-7
Hauska, H.	S-30
Haydn, R.	B-21, B-22
Hecht, A. S.	H-18
Heinrich, M. L.	M-12
Helbig, H. S.	H-19
Henrikson, P. J.	B-28
Henze, J.	H-20
Herzog, J. H.	H-21, H-22
Higham, A. D.	H-23
Hitchcock, H. C.	H-24
Hoffer, R. M.	F-3, H-24, H-25, H-26, H-27, L-6
Hoffman, R. J.	H-28, S-11, T-7
Hofmann, D.	H-29
Honey, F. R.	H-30
Hord, R. M.	H-31, H-32
House, D. R.	F-4
Howard, G. E.	H-33
Howry, J. E.	Mc-2
Hoyt, R. R.	L-22
Hsiao, S.	L-14
Hsu, S.-Y.	H-34, K-5, K-6
Huang, T. S.	H-35, W-16, W-17, W-18
Hubbard, R. G.	H-36
Hulstrom, R. L.	S-3
Humiston, H. A.	H-37
Hunt, B. R.	H-38, H-39

Idelsohn, J. M. I-1
Iwasa, S. N-7

Jancaitis, J. R. J-1, J-1a
Jayroe, R. R., Jr. A-11, J-2, J-3, S-26
Jensen, J. R. J-4
Johannsen, C. J. K-16
Jordan, R. L. B-13
Joyce, A. T. J-5

Kalensky, Z. K-1
Kan, E. P. K-2, K-3
Katz, Y. H. H-32
Kawamura, J. G. K-4
Kedar, E. Y. K-5, K-6
Kelly, R. E. K-7
Kennedy, J. G. K-8
Kettig, R. L. K-9, K-10
Keuper, H. R. K-11
Kirkham, R. G. K-12
Kirvida, L. K-13
Kishner, S. J. A-17
Klemas, V. K-14
Kothe, K. R. K-15
Kramer, H. H. B-12
Kristof, S. J. K-16
Kritikos, G. K-17
Kruger, R. P. A-10
Krusinger, A. E. R-10
Kubik, K. B-29, B-30
Kulkarni, A. V. A-5
Kunkel, W. A. K-18

Labonte, A. E. L-1
Lamdan, T. M-9
Landgrebe, D. A. B-12, K-10, L-2, L-3, L-4 L-5, L-6, S-30
Langford, C. J. B-5
Larson, R. W. L-7
Latham, J. P. L-8
Leachtenauer, J. C. L-9, L-10
Leamer, R. W. L-11
Lee, S. H. L-12
Lee, Y. J. L-13
Leib, K. G. L-14

Leighty, R. D.	B-7, L-15, L-16, L-17 L-18, L-19
Leschack, L. S.	L-20
Lietz, J. C.	F-4, F-5, L-21
Lillestrand, R. L.	L-22
Lindenlaub, J.	L-23
Lock, B. F.	V-5
Lorre, J. J.	R-24
Lucey, D. J.	F-5, L-25
Lukes, G. E.	L-26, L-27, L-28
Lybanon, M.	A-20
Lyon, R. J. P.	H-30
McCallum, S. J.	L-1
McConnell, P. R. H.	K-7
McEwen, R. B.	Mc-1
McHugh, A. P.	Mc-2
McIvor, D. E.	L-20
McKnight, J. S.	R-14
McMurtry, G. J.	Mc-3
McNaughton, J.	U-1
McNee, F. J.	Mc-4
Malila, W. A.	M-1
Manning, B. N.	B-13
Marien, H. R.	B-39
Mark, J. W.	M-2
Martin, J. D.	B-19
Martin, W. N.	M-3
Mead, R. A.	M-4
Meyer, M. P.	M-4
Mildenberger, S. L.	K-7
Milgram, D. L.	M-5
Miller, L. D.	P-4, S-28
Miller, S. H.	M-6
Mitchel, R. H.	M-7
Moik, J. G.	P-7
Moore, D. G.	M-17
Moore, R. K.	M-8
Moore, W. R.	J-1
Mor, M.	M-9
Moritz, S. H.	M-10
Mower, R. D.	M-11, M-12
Mucciardi, A. N.	M-13
Mulder, N. J.	D-14

Murphrey, S. W.	M-14
Murphy, L. P.	L-28, M-15, M-16, T-6
Mutter, D. L.	N-3
Myers, V. I.	M-17
Nalepka, R. F.	M-1
Nasu, M.	N-1
Nazar, T.	S-12
Nelson, G. D.	M-17
Nez, G.	N-3
Ng, K. Y. K.	N-4
Nichols, D. A.	N-5, R-14
Nichols, J. D.	N-6
Nisenson, P.	N-7
Nunez de las Cievas	N-8
Ochiai, H.	O-1
Odenyo, V. A. O.	O-2
O'Handley, D. A.	O-3
Ohi, K.	O-1
Optiz, B. K.	L-21
Palmer, R.	P-1
Panton, D. J.	B-27, P-2, P-3
Park, A.	A-2
Park, K. Y.	P-4
Peet, F. G.	D-8, D-9, P-5
Pentland, A. P.	P-6
Peplies, R. W.	K-11
Petersen, G. W.	Mc-3
Pettry, D. E.	O-2
Phillips, T. L.	H-27
Pillars, W. W.	V-7
Podwysocki, M. H.	P-7
Pomphrey, R. B.	R-24
Pooley, J. C.	S-27
Postma, R.	N-5
Potter, A. E., Jr.	P-8
Poulin, A. O.	R-10
Power, M. A.	R-24
Prager, J. M.	P-9
Prelat, A.	H-30
Pressman, A. E.	D-17
Preston, K., Jr.	P-10

Quam, L. H.	Q-1, Q-2
Quinqueton, J.	C-1
Radosevic, R. G.	C-10
Ramapriyan, H. K.	A-20
Rathja, R. C.	H-21
Ray, R. M.	R-1
Reed, L. E.	K-14, R-15, R-16
Reel, G. M.	S-3
Reggiori, G. B.	R-4
Rey, P.	R-5, R-6
Rhodes, W. T.	R-7
Richardson, A. J.	R-9
Rinker, J. N.	R-10
Riseman, E. M.	R-11
Robinove, C. J.	R-12
Roche, C.	R-13
Roehring, D. R.	R-14
Rogers, R. H.	K-14, R-15, R-16
Rosenfeld, A.	R-17, R-18, R-19, W-8, W-9, Z-4
Ross, M. H.	R-20
Rothenberg, D.	R-21
Rotz, F. B.	R-22, R-23
Rouge, J.	H-4
Rouse, J. W., Jr.	H-15
Ruiz, R. M.	R-24
Russell, J.	L-23
Russell, M. J.	M-17
Sahai, B.	K-17
Salmon, B. C.	V-7
Sarno, J. E.	M-1
Schaefer, D. H.	S-1
Schaller, E. S.	S-2
Schappell, R. T.	S-3
Schmidt, R. G.	S-4
Schmidt, W. E.	C-10, S-21
Schroeder, M. O.	B-27
Schubert, J.	C-4
Schulz, B. S.	S-5
Seemuller, W. W.	C-8
Sellner, H. R.	A-17
Senkus, W. M.	N-6
Shah, N. J.	R-16
Shanmugam, K. S.	D-13, H-14

Shapiro, L. G.	S-6
Sharma, G. C.	D-16
Shelton, C. B.	M-10
Shlien, S.	S-7, S-8, S-9
Shoup, W. C.	P-7
Shuchman, R. A.	W-1
Siegal, B. S.	G-2
Silva, L. F.	B-18
Silverman, H. F.	B-9
Simonett, D. S.	S-10
Skaley, J. E.	S-11
Smelser, R. L.	K-3
Smith, A.	S-9
Smith, D. M.	A-2
Smith, V. E.	R-16
Solomon, S. I.	S-12
Sprague, R. A.	N-7
Stark, H.	S-13, S-14
Stein, M.	V-6
Steiner, D.	S-15, S-16
Stephens, C. W.	S-17
Stepler, P. F.	A-8, S-18, S-19, S-20, S-21
Stevens, G. T.	F-4, L-21
Stevenson, M. R.	K-12
Stockman, G.	S-22
Stohr, C. J.	F-6, W-7
Struve, H.	S-23, S-24
Sturm, B.	H-22
Su, M. Y.	S-25, S-26, S-27
Sung, Q. C.	S-28
Swain, P. H.	D-7, E-5, R-1, S-29, S-30
Swanlund, G.	S-31
Takeuchi, S.	O-1
Tavakoli, M.	B-2, B-3, B-4
Tenenbaum, J. M.	T-1
Tescher, A. G.	A-10
Tessar, P. A.	T-2
Thomas, D. T.	B-26
Thomas, J. D.	R-1
Tietz, J. C.	S-3
Tisdale, G. E.	H-37, T-3, T-4
Tonelli, A. M.	T-5
Towler, F.	L-13
Towles, R. W.	S-2

Trelinskie, E. G. T-6, V-9
Triendl, E. K-17
Turinetti, J. D. T-7

Ulaby, F. T. U-1
Underwood, D. J-3

Vajo, V. V-1
Van de Lindt, W. J. V-2
Vanderbilt, V. C. A-1
Vanderbrug, G. J. V-3, V-4
Van Genderen, J. L. V-5
VanWie, P. V-6
Vass, P. A. V-5
Verger, F. D-6
Vincent, R. K. V-7
Virkler, G. C-12
Vogel, T. C. V-8, V-9

Wagner, H. W-1
Warren, M. E. W-2
Watanabe, M. S. W-3
Watrasiewicz, B. M. R-20
Watson, K. M-6
Weber, D. A. L-11
Weber, W. B. W-4
Wecksung, G. W. W-5, W-6
West, H. W. S-24
West, T. R. F-6, W-7
Weszka, J. S. W-8, W-9
Weyl, S. T-1
Whitley, S. L. W-10, W-11, W-12
Widrow, B. W-13
Wieczorek, U. W-14
Wiegand, C. L. L-11, R-9
Wightman, J. M. P-5
Willett, T. W-15
Williamson, A. N. K-8
Wintz, P. A. G-7, W-16, W-17, W-18
Wolf, D. E. H-3
Wolf, H. C. T-1
Wolfgang, P. A. T. B-32
Woll, A. M. L-10
Wong, K. W. W-19

Wong, R. Y. H-5, W-20
Woodring, S. M. W-7
Wray, J. R. E-5
Wu, C. L. S-30
Wyant, J. C. E-1

Yagi, G. M. R-24
Yakimovsky, Y. Y-1
Yasuda, Y. Y-2

Zanon, A. J. L-21, Z-1
Ziman, Y. L. Z-2
Zobrist, A. L. B-37, B-38
Zobrist, G. W. Z-3
Zoracki, M. J. L-25, Z-1
Zucker, S. W. Z-4